# THE FOUNDRY

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# FOUNDRY DUST EXHAUST SYSTEMS

## Installations for removing the dust from cleaning, grinding and polishing departments---Construction of exhaust hoods

IN THE construction of new foundries and when remodeling existing plants, the problem of disposing of the dust from the cleaning, grinding and buffing departments, is considered of prime importance, inasmuch as it involves the welfare of the employes of these departments, and the economies effected by the installation of these systems are largely in the form of increased output. The Davis Sewing Machine Co., Dayton, O., has six dust collecting systems in operation, installed by Kirk & Blum, Cincinnati. The four departments in which these six systems have been installed contain 40 tumbling barrels, 36 rough grinders and 38 buffing and polishing lathes. The tumbling barrels and rough grinders exhaust into an 80-inch steel plate fan. Two branches of the main suction pipe extend over the tumbling barrels in the cleaning department and each barrel is connected to one of these branches by a 3½-inch pipe. A section of the tumbling room is shown in Fig. 3. The main suction pipe is upwardly inclined toward the fan. The small suction pipes are connected with the tumbling barrels and are equipped with valves whereby the air is cut-off when the machines are not in use. In the rough grinding department the 36 grinders exhaust into one main suction pipe carried overhead, as shown in Fig. 2, which discharges into the same fan that furnishes the exhaust for the tumbling department. To the adjustable hood of each grinder is connected a 4½-inch suction pipe. These hoods are adjustable and cover a large part of the wheel. A vertical, movable cast iron rest with the top edge on a level with the center of the grinding wheel, is attached to the bench at the front of each wheel. The castings are held on these rests while being ground.

As the dust and small particles exhausted from the tumbling and grinding departments have nearly the same specific gravity, one collecting system is used for both. The 80-inch fan discharges into a brick dust collector, 10 feet inside diameter and 18 feet high. On top of this brick dust collector a dome-shaped air outlet has

FIG. 1—ARRANGEMENT OF LATHES IN THE POLISHING DEPARTMENT OF THE DAVIS SEWING MACHINE CO.'S PLANT WHICH CLEARLY SHOWS THE EXHAUST HOODS

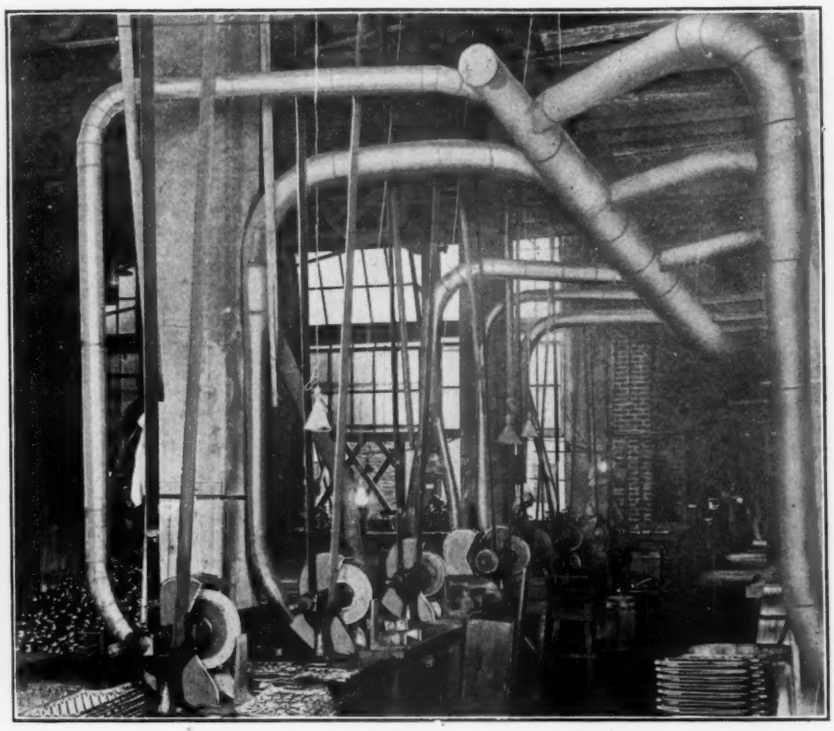

FIG. 2—A SECTION OF THE ROUGH GRINDING DEPARTMENT, SHOWING THE EXHAUST HOODS WITH WHICH THE WHEELS ARE EQUIPPED

been built which terminates in a 42-inch vertical vent pipe which is carried above the shop roof. Sheet steel deflectors are located inside of the collector and when the air enters the collector, it has a swirling motion, which directs the metal particles against the periphery of the wall. The air escapes through the vent pipe in the center of the collector. Tests show that only about 1 per cent of the dust collected escapes with the air through the vent pipe. While the exhaust system is in operation the lower part of the collector is sealed, but when the dust reaches a height of three feet the collector is cleaned and the dust removed. As this metallic dust is highly abrasive, the inside of the outer arc of each elbow in the suction pipe is flat, consisting of a section of sheet steel which can be readily removed and replaced when worn, without replacing the entire elbow.

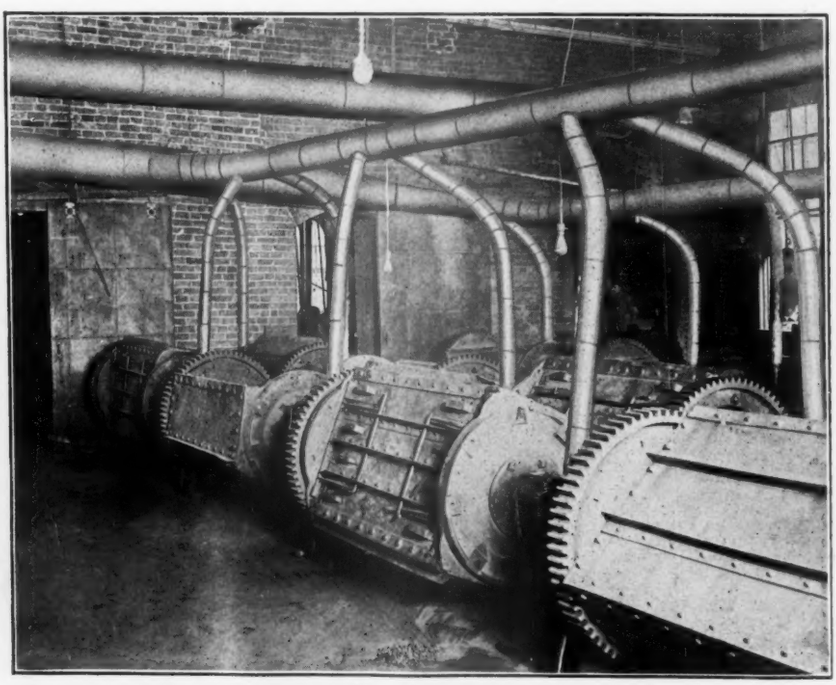

FIG. 3—SECTION OF THE CLEANING DEPARTMENT, SHOWING THE EXHAUST SYSTEM FOR THE TUMBLING BARRELS

In the buffing and polishing departments six dust collecting systems have been installed, three of which exhaust into fans located directly outside of the building. These three systems exhaust from three rows of polishing lathes arranged in parallel in the center and at either side of the shop. One installation exhausts from 11 lathes to a 55-inch steel plate fan, another carries the exhaust from 15 lathes to a 60-inch fan and the third exhaust from 18 lathes for small work to a 55-inch fan. The three installations discharge into a heavy steel dust collector set on a brick receiver, 15 feet high and 10 feet in diameter. The three fans are located at the end of the building and are on a level with the floor on which the lathes are operated. These fans are individually driven by 15-horsepower motors. The dust collector and the suction pipes from these fans are shown in Fig. 7. This three-in-one system, according to tests made at different times, shows a power consumption of only 37 horsepower for maintaining a 4-inch pressure on 44 polishing and buffing lathes.

### New Departments.

The Davis Sewing Machine Co. recently extended its plant by the erection of a three-story concrete building and one-half of the second and third floors are occupied by an extension to the buffing and polishing department. Three dust collector systems serve the polishing room on the second floor. One 80-inch fan driven by a 20-horsepower motor exhausts from 14 buffing lathes. This fan is located directly outside of the building and discharges into a 34-inch dust collector. A special deflector prevents the expanding air from cutting off and choking back the incoming air, thereby eliminating the back pressure. The dust is precipitated into a brick receiver underneath the collector. Another exhaust system in the polishing room is driven by a 70-inch fan operated by a 20-horsepower motor and serves 14 polishing lathes and discharges into a 30-inch collector set on a brick receiver.

On the third floor, the exhaust system connected with 16 polishing lathes, is operated by a 70-inch fan. The fan is located on a platform at one side of this department and exhausts into a twin collector located at the side of the two collectors which

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form a part of the second floor exhaust system. These dust collectors are shown in Fig. 6. In Fig. 4 is shown the arrangement of the grinding and polishing wheels in one department, which clearly illustrates the arrangement of the exhaust pipe.

### Buffing Department.

A section of the buffing department is illustrated in Fig. 1. The main suction pipe, *A*, is located underneath the benches at the backs of the lathes. The arbor of each lathe carries two wheels with a driving pulley in the center. The exhaust hoods for these lathes are shown in Fig. 5. The hoods are made of No. 20 gage, galvanized sheet steel and are adjustable to the class of work handled on the lathe. Sections *A* and *B* of the hood, shown in Fig. 5, are adjustable and can be moved back into the main section of the hood when it becomes necessary to increase the arc of the wheel exposed for certain kinds of work. The caps are held in position by thumb screws which clamp the sides of the hood together. When removing the wheel from the arbor the upper part of the head, *D*, is swung back on a hinge. A pocket, *E*, is provided to catch heavy particles that are not carried off by the exhaust. A slide, *F*, at the base of the pocket, is provided for removing the accumulated particles. Very little dust is precipitated into these pockets, owing to the high pressure of the exhaust. The method of mounting the polishing wheels is clearly shown in Fig. 5.

When designing these exhaust systems, equalizing suction pipes were dispensed with and the diameters of the suction pipes and the exhaust pressures were calculated with a view to carrying the material through the pipes at as low a velocity as possible and at the same time to hold the material in suspension. The friction losses in the various branch pipes leading to the wheels were calculated to provide the same pressure at every wheel, regardless of the distance it was located from the fan. The exhaust pressure at each wheel is not less than 4 inches and the fans used throughout the plant operate at an average of 700 revolutions per minute.

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The melting of scrap aluminum wire in crucibles is a tedious operation unless the metal is solidly balled, and this is a matter of considerable difficulty in the case of heavy wire. In one case the cost of melting this material amounted to approximately $2.61 per 100 pounds of metal.

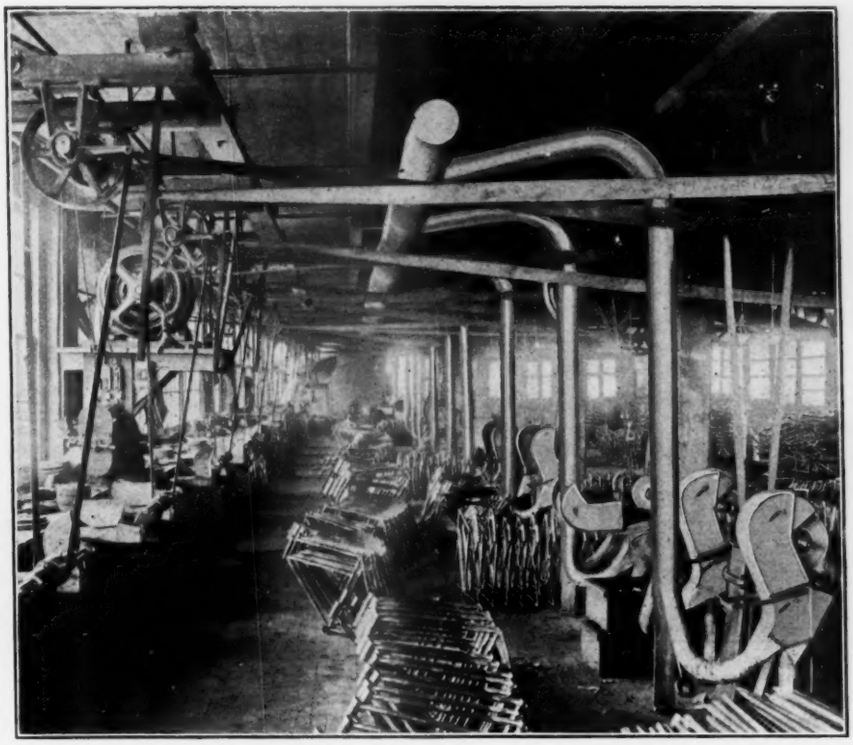

FIG. 4—POLISHING WHEELS IN ONE SECTION OF THE DAVIS SEWING MACHINE CO.'S PLANT, EQUIPPED WITH EXHAUST HOODS

## Strong Iron

*By W. J. Keep*

*Question:*—We would like to have a mixture for stove plate that will give us a transverse test of 2,500 pounds on a one-inch square bar, 12 inches long. Our present mixture analyzes as follows: Silicon, 2.6 per cent; manganese, 0.6 per cent; phosphorus, 0.75 per cent; sulphur, 0.055 per cent and total carbon, 3.30 per cent. Our average tests vary from 1,900 to 2,100 pounds per square inch.

*Answer:*—It is evident that you believe that a chemical formula can be given which will produce a soft iron with 2,500 pounds transverse strength per square inch on the size of test bars you have given. You will find by experience, however, that you can get

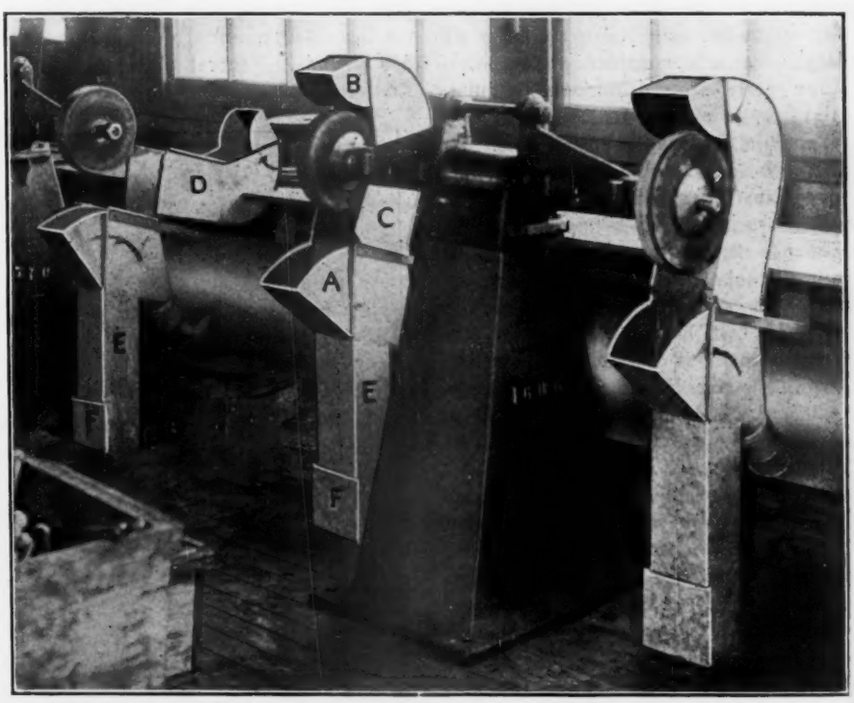


FIG. 5—ONE OF THE POLISHING STANDS EQUIPPED WITH TWO WHEELS, SHOWING THE EXHAUST HOODS

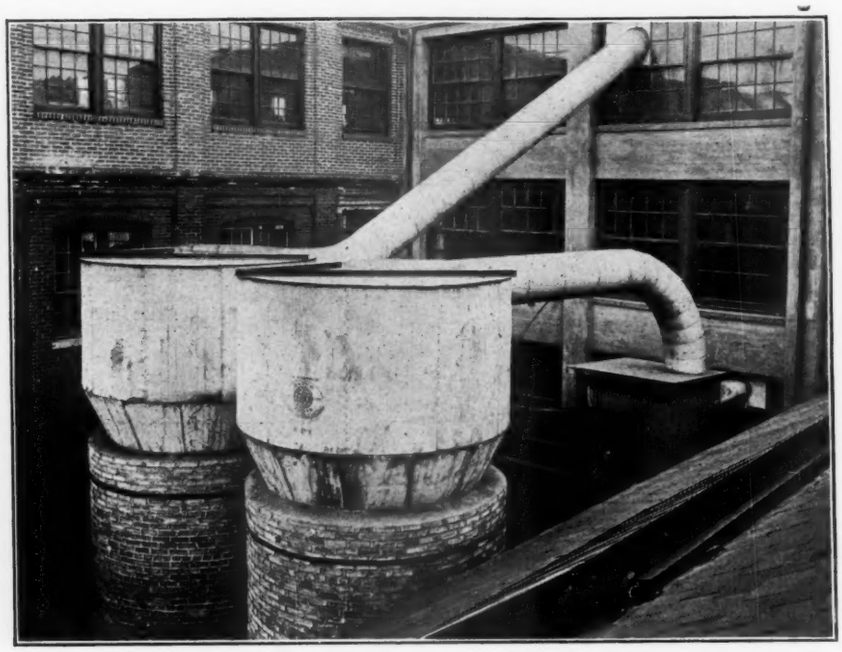

FIG. 6—A VIEW OF SEVERAL OF THE DUST COLLECTORS

a strong mixture with almost any analysis and you will find further that strength depends more on the shape and size of the grain of the iron than upon the chemical analysis of the mixture. You can produce a strong iron by varying the proportions of any of the irons available in your market, or which you may have in your yard at the present time. If you were to use a one-half-inch test bar in an autographic testing machine you would find the work interesting and rapid and your one-inch bar would be proportionately as strong, not as to the variation in size, however, but in proportion to the size and grain. For example we will consider a sample of stove plate iron from our ordinary mixture. It analyzed as follows: Total carbon, 3.23 per cent, of which 0.15 per cent was combined in a one-inch square test bar; silicon, 2.80 per cent; phosphorus, 0.801 per cent; sulphur, 0.096 per cent, and manganese, 0.60 per cent. A chemist would say that the iron you are using would give a stronger test bar, but our iron produced a pair of one-inch square test bars, 12 inches long, which broke at 2,420 and 2,762 or an average of 2,591 pounds. The average of three bars ½ inch square by 12 inches long was 378 pounds. By the formula a test bar one inch square by 12 inches long of the same iron, if of the same grain, would be eight times as strong or 3,024 pounds, but by actual test of two bars the average strength was 2,591 pounds, the difference being due to the heat treatment. The test bars were left in the sand over night and in the one-inch square bars the grain was more open and coarser than in the one-half-inch bars. In the latter the combined carbon was 0.23 per cent, because the bar cooled faster and this made the grain finer.

We try to keep the strength of one-half inch square bars to over 400 pounds. The one-inch square test bars would also be stronger, but if the silicon were higher, perhaps not as strong as with lower silicon. Strength may be varied without reference to the chemical composition. For example, I once tested two sets of one-half inch square test bars, three test bars in each set. The strength of one set was 440 pounds and of the other 530 pounds. Several chemists claimed that they could not give a chemical formula which would produce such strength, unless they made an analysis of the bars. The analysis proved them to be of exactly the same composition, because both sets of bars were cast from a 28-pound ladle of stove plate iron. After pouring the first three bars, which were weakest, the remaining iron was stirred rapidly until it would just run and then the other three strong bars were poured.

Strength is largely a question of grain. If you produce a one-inch square test bar, 12 inches long, which will break at 2,500 pounds, you would naturally make the silicon 2.10 per cent, which would not make good stove plate; but as previously stated, if you increase your silicon from 2.75 to 3.00 per cent you can, by varying the irons in the mixture, obtain a strength of 450 pounds in a one-half-inch square test bar and 2,500 pounds in a test bar one inch square and 12 inches long. You, however, do not require a one-inch square test bar giving a strength of 2,500 pounds. You are making stove plate and, therefore, want the strength in the plate or casting. If your one-half inch square test bar, 12 inches long, breaks at 300 to 440 pounds, your stove plate is very strong, but the silicon will be close to 3.00 per cent, which would weaken the one-inch square test bar.

With high silicon, thin castings will be strong and thick castings will be weak, owing to the coarse grain. With low silicon, thin castings will be hard and perhaps weak because brittle, but thick castings will be strong and soft enough to machine because it takes them longer to cool and this gives the carbon time to change from combined to graphitic form.

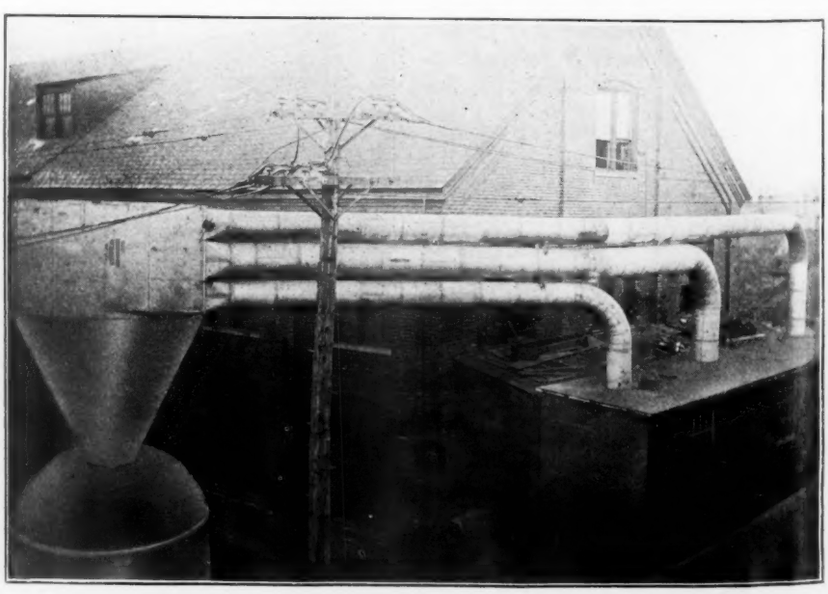

FIG. 7—DUST COLLECTOR SYSTEM FOR THREE EXHAUST FANS

# OIL-FIRED OPEN-HEARTH FURNACES*

## Design and construction of furnaces for the production of steel castings---Calculating the sizes of the hearth, flues, etc.

*By Walter MacGregor*

IN DISCUSSING the subject of open-hearth furnaces for the production of steel for small castings, I will confine my remarks to fuel oil furnaces, as operating with this fuel when the furnace is properly designed, the melter will have fewer difficulties to contend with.

If we turn a moment to the steam engineering profession we will see that the engineers, in well-conducted power plants, are giving their greatest attention to the problems of combustion and in the case of plants already in operation, experimenting to find a grade of fuel best suited to their type of furnaces.

It is a well understood fact among these engineers that the design of a furnace, to get the best efficiency from the fuel, depends entirely upon the nature of the fuel to be burned. Obviously, as we are to deal in high temperatures we are, therefore, to pick out a fuel high in heat value and design our furnace to suit the combustion of this fuel.

### Highest Heat Values.

In order to get the highest heat our furnace body should be of such proportions that we can burn the necessary amount of fuel in the smallest possible space, and in order to burn a large amount of combustible in a small space, a short flame is necessary.

The factors governing the short flame, according to the fuel experts of the United States navy, are first, a pure carbon fuel; second, initial heating of the air which furnishes the oxygen for combustion; third, intimate mixture of the oxygen with the fuel or diffusion; fourth, large surface of the fuel presented for impact of this oxygen.

The first factor, the nature of the fuel, is settled for us, as we have decided upon fuel oil with a probable analysis, as follows: Carbon, 83.26 per cent; hydrogen, 12.41 per cent; sulphur, 0.50 per cent; oxygen, 3.83 per cent, with a specific gravity at 60 degrees Fahr. of 0.926.

The heat value of this fuel, according to Du Long's formulae, would be 19,481 B. T. U.'s per pound. From this analysis we can easily compute the quantity of air required for combustion and the products of combustion for any amount of fuel burned.

### Five-Ton Furnace.

As a representative size of the small open-hearth furnace we will choose a five-ton furnace as an example and discuss the conditions that will determine the proper furnace proportions. We are to melt and reduce five tons of metal and the time from charging the heat until the time of charging the following heat we will assume to be four hours. As the oil consumed varies so much in different furnaces, we will assume as an average fuel consumption 48 gallons of oil per ton of steel melted in this time or one gallon per minute.

Considering 12 pounds of air required for burning one pound of carbon and 34.78 pounds of air required for burning one pound of hydrogen, we have from the analysis of the fuel:

9.9912 pounds of air to burn the total carbon in fuel.
4.2161 pounds of air to burn the total hydrogen in fuel.

14.2073
.16 Correction for oxygen in fuel.
14.0473 Pounds air for complete combustion of one pound of liquid fuel.

With fuel oil of 7.72 pounds per gallon, we have $14.047 \times 7.72 = 108.37$ pounds of air required per gallon of oil.

With air at 13.14 cubic feet per pound we have $108.37 \times 13.14 = 1,424.11$ cubic feet of air required to burn one gallon of fuel oil.

Hence, to burn one gallon we must admit, theoretically, 1,424 cubic feet of air per minute into the furnace. To this we must add the amount of air required in reducing the carbon and silicon in the metal.

### The Furnace Charge.

We have a 10,000-pound charge, of which 12½ per cent is pig iron and about 2½ per cent carbon and the rest steel scrap and billets of about 0.30 per cent carbon, to be reduced to about 0.18 carbon at the time of tapping. From this we get the total carbon content of the bath, 56.5 pounds, to be reduced to 18 pounds of carbon, or $56.5 - 18 = 38.5$ pounds of carbon, to be burned out in about two hours of reducing the charge. As 157.6 cubic feet of air are required to burn one pound of carbon and we will require $157.6 \times 38.5 = 6,070$ cubic feet air in two hours or 50 cubic feet per minute. All of this passes off with the products of combustion. In the same way we can determine the amount of air required in eliminating the silicon, which will run about 42 cubic feet per minute. A certain amount of oxygen is also taken up by the manganese, but this is so small as to be negligible.

With the total theoretical amount of air required, $1,424 + 50 + 42 = 1,512$ cubic feet per minute, we are in a position to determine the proper furnace proportions with due regard to the second circumstance in producing the short flame.

### Volume of Air.

The volume of air is figured at a temperature of 72 degrees Fahr., which will be about the temperature of air entering the valve. The increase in volume of air at different points along its travel due to its increase in temperature must be the governing factor in designing the ports, flue openings, etc., and as the volume of this air increases in direct ratio to the absolute temperature, it follows that the volume occupied at any point may be computed when the temperature at that point is known.

In the case of the air valve, due to the reversing feature of the furnace, this should be figured rather to accommodate the products of combustion than the entering air as these are at a higher temperature and will, therefore, require a greater area of flue.

The temperature of the valve is a vital point in the problem of design, for any heat beyond this point toward the stack is lost, as far as the furnace is directly concerned, and can only be used in the field of economizers. In determining the size of the valve, we will first have to determine the velocity of the products of combustion through the valve due to the draft of the stack and this, in consequence, gives as our starting point—the design of the stack—which we would naturally consider as our finishing point.

A number of eminent authorities on chimney design have chosen 600 de-

*Presented at the Pittsburg convention of the American Foundrymen's Association.

grees Fahr. as the most economical stack temperature and Rankine has spent considerable time in trying to prove it in his work on "Steam Engines." I have never seen an open-hearth stack with that low a temperature and will, therefore, base my calculation on a temperature of 1,000 degrees Fahr. as being more nearly uniform with current practice. In my experience with small furnaces, I find that the most satisfactory stack draft to be maintained is about one inch of water. This is a function of the height of the stack and the difference in temperature inside and outside the stack. With this difference in temperature and a draft of one inch of water we would get a stack 110 feet high and hence, we will assume this as the minimum height to be desired. The velocity of gas due to the pressure head corresponding to this height of stack and temperature, allowing a 25 per cent friction factor, is a little less than 15 feet per second, which is recommended by a number of authorities as good practice.

We have based our calculation so far on the theoretical amount of air required for combustion, but will design our stack and flues as in the case of power plant design, for an excess capacity of 100 per cent which would be 3,000 cubic feet of gas per minute or 50 cubic feet per second. This divided by the velocity of 15 feet per second would give a sectional area of stack of 3 1/3 feet or a trifle over two feet in diameter and we will assume 27 inches diameter of stack as best suited to this furnace and plenty large enough to permit of any crowding of the furnace. This then will also be the size of the valve and flues leading to the valve from the checker chambers.

### Initial Heating of Air.

The second factor governing the short flame, "The initial heating of the air," is introduced by means of the reversing feature of the furnace through the checker chambers, and these chambers should be so designed as to slow up the travel of the products of combustion in order that they may give up the major part of their heat to the checker brick, or that part of the heat which is not required to produce the stack draft. The cubical contents of these chambers should not be less than 75 cubic feet per ton of steel melted per heat and preferably in the neighborhood of 100 cubic feet per ton. These chambers should be located behind the furnace and not immediately under the furnace. This point is quite as important in small furnaces as in large ones, as they operate at a higher temperature, and we should get the benefit of a good circulation of outside air under the hearth of the furnace. These chambers should be long and narrow or deep, in oil-burning furnaces, giving a very long travel to the products of combustion before they reach the valve, as on account of the highly volatile nature of the fuel and the slowness with which many of the hydrocarbons mix with oxygen, a great deal of the fuel will be out in the stack before it has undergone complete combustion.

The methods of gas analysis as applied to steam boiler practice will show some very interesting relations in this regard. In a five-ton furnace which I have been operating, a flue gas analysis will show the following:

| | $CO_2$ Per cent. | CO Per cent. | O Per cent. |
|---|---|---|---|
| At the rear of the checker chambers, 24 feet back of the center line of furnace ..... | 6.4 | 3.1 | 0.2 |
| In the air valve, 9 feet further back ..... | 8.8 | 0.3 | 8.0 |
| In the stack, 16 feet further back ..... | 9.4 | 0.3 | 9.0 |

With a decrease in temperature between the first and last point from 1,750 degrees Fahr. in the rear of the chambers to 930 degrees Fahr. in the stack.

### Long Chambers and Flues.

In case all the fuel were burned before it reached the stack, the sum of the oxygen components of the flue gas would be 21 per cent, as there is 21 per cent by volume of oxygen in all the air admitted to the furnace, the volume of the carbon element being so small as to be considered zero. As a matter of fact, however, the sum of the oxygen components at the valve is only 17.1 per cent and even out in the stack it is only 18.7 per cent, which shows that there is some form of hydrocarbon gas occupying the other 4 per cent which is getting past the valve unburned and is being wasted out in the stack. This, I think, shows very conclusively the necessity of having long chambers and flues in oil-burning furnaces, to insure complete combustion of the gaseous fuel before reaching the reversing valve.

These figures are based on atomizing the fuel with compressed air instead of with steam, as with steam the hydro-carbons are slower in taking up oxygen and a gas analysis at the valve will show a higher percentage of hydrocarbon gas unburned at the valve and a corresponding increase in stack temperature. A sample of gas at the base of the stack when steam was used for atomizing purposes, showed the following analysis: $CO_2$, 7.5 per cent; CO, 0.4 per cent, and oxygen, 9.5 per cent, or a total of 17.4 per cent of oxygen components out in the stack, which is 5½ per cent less than shown at the base of the same stack with air and, therefore, a less perfect combustion.

### Air Ports and Furnace Body.

The third condition governing the short flame, "Intimate mixture of oxygen with the fuel or diffusion" bears directly on the size and arrangements of the air ports and the furnace body. The size of the ports depends upon the size of the reversing valve, or vice versa, and the relation between the two is in a direct ratio to the absolute temperature at the two points, these temperatures being 1,490 degrees Fahr. at the valve and 2,800 degrees Fahr. at the ports, or in a ratio of 1 to 2. The ports, therefore, should have an area of twice the area of the reversing valve. We will, therefore, have a total port area at one end of the furnace of about seven feet. These ports should be carried out the full width of the furnace to prevent any short circuit of air through the furnace body, as the travel of gas through the furnace body should have the same velocity at all points to get the proper diffusion. These air ports should come well up above the hole in the monkey wall through which the oil burner enters the furnace, so that the air must come down on top of the flame rather than underneath it. This is a very important factor in designing a hot working furnace.

### Hearth Space.

The space to be allowed for hearth in small furnaces should not be under ten square feet per ton of charge and the shape should approach more nearly a square than the oblong shapes in general use, as this tends to give a better effect of the radiation of the walls and roof, and by widening the furnace, we lessen the cutting action of the flame on the side walls and keep down the repair bills.

As to the length of the furnace body this should be governed by the length of the oil flame, for the hottest part of the flame should be about the center of the furnace. It has been my experience that I have not been able to get a flame that was intense enough to melt down a charge of metal any less than about eight feet from the tip of the burner to the hottest part of the flame, and as the tip of the burner should pass clear through the monkey wall, which will extend nine inches beyond the ports of the furnace at least, we will get as a

minimum furnace length, twice the length of the flame previously mentioned, plus twice the width of the ports, plus twice the thickness of the end walls, plus twice the nine-inch extension of the monkey wall beyond the ports, or a total of about 22 feet as the minimum length of the outside of the furnace body.

### Large Fuel Surface.

The fourth factor governing the short flame, "Large surface of fuel presented for impact of oxygen," is a matter of oil burners and atomizing agents and has furnished inspiration to thousands of inventors. The problem of atomizing this fuel oil is one of overcoming the surface tension of the oil and breaking it up into very fine particles so that it will present a greater surface for contact with the oxygen and the two methods in use, superheated steam and compressed air, give a low mechanical efficiency.

There is a great deal of discussion at the present time on the needless waste of using compressed air for atomizing purposes when superheated steam will answer, but in the small casting business one of the main difficulties is getting the metal hot enough to run the thin sections in the molds and, since by its very nature, compressed air while atomizing the oil, furnishes at the same time oxygen for combustion, and that, too, very intimately mixed with the oil, it is quite evident, that by using air we would get quicker combustion, a shorter flame and a somewhat hotter furnace.

In conclusion I will say that in operating a furnace designed along these lines it will not be a difficult matter to get out six, five-ton heats in 24 hours, and still have the metal hot enough to pour many castings weighing a fraction of a pound each. With a five-ton heat it is not uncommon to pour as high as 175 molds, consuming about 50 minutes in pouring. The metal must, therefore, be extremely hot at the time of tapping the heat.

# The Annealing of Steel Castings*

*By Bradley Stoughton*

THE annealing of steel castings is not always a necessary operation in their manufacture, and especially in the manufacture of small steel castings which have not great length to produce severe strains by shrinkage. While it cannot be denied that proper annealing must benefit all steel castings in greater or less degree, on the other hand, annealing, as too frequently practiced, is often more of a detriment to some castings in the heat than it is a benefit to the remainder. Annealing has the two-fold purpose of relieving any strains produced in the metal during cooling in the mold, and of improving the strength and ductility of the metal by breaking up the coarse structure inevitably developed to some extent during cooling from solidification and, in some cases, amounting to that extreme degree of coarse crystallization which causes the appearance known as *ingotism*. Annealing to relieve strains is a comparatively simple operation, but annealing to produce the best grain obtainable, which shall in turn give the highest possible combination of strength and ductility to the casting, is an operation so often imperfectly understood and crudely practiced in foundries, that I hope an interchange of ideas may be of benefit, even though I cannot offer anything new or revolutionary for consideration.

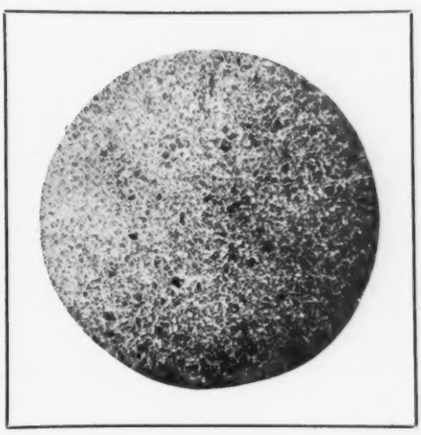

FIG. 1—MICRO-PHOTOGRAPH OF STEEL CONTAINING 0.50 PER CENT CARBON; GRAIN OF ROLLED STEEL
(Magnified 40 diameters.)

The microscope and some form of pyrometer, however crude, is an invaluable adjunct to annealing practice. The time has passed when steel foundries can obtain the best results in competition by means of the unaided eye. The pyrometer will tell us when the steel has reached that temperature which will give to it the best grain, and, therefore, the best physical properties, while the

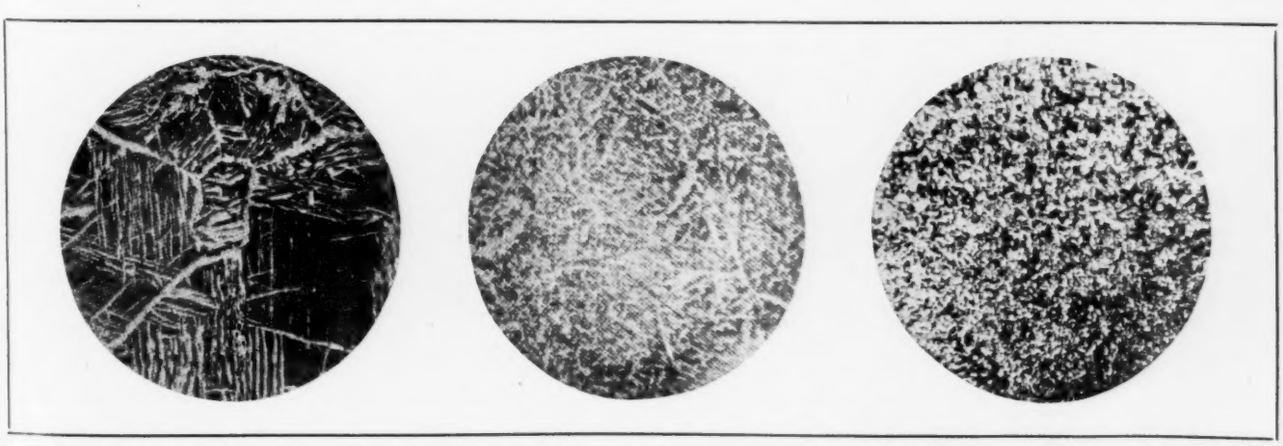

FIG. 2—SAME STEEL AS FIG. 1; COARSE GRAIN DUE TO HEATING TO HIGH TEMPERATURES
(Magnified 40 diameters.)

FIG. 3—SAME STEEL AS FIG. 2; REHEATED TO REFINE THE GRAIN
(Magnified 40 diameters.)

FIG. 4—STEEL OF 0.05 PER CENT CARBON; GRAIN OF ROLLED STEEL
(Magnified 40 diameters.)

*Presented at the Pittsburg convention of the American Foundrymen's Association.

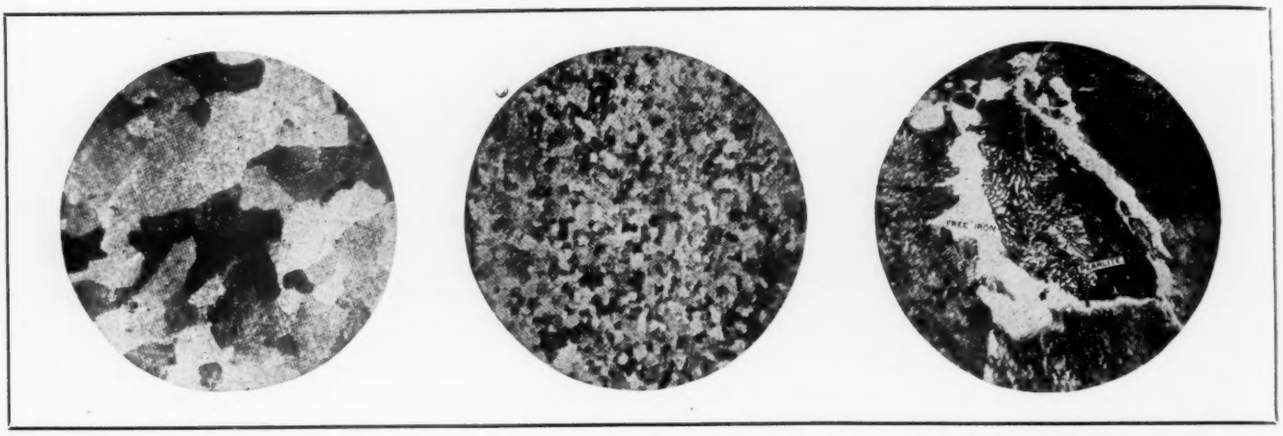

FIG. 5—STEEL, 0.05 PER CENT CARBON, HEATED TO HIGH TEMPERATURES
(Magnified 40 diameters.)

FIG. 6—SAME STEEL AS FIG. 5; REHEATED TO REFINE GRAIN
(Magnified 40 diameters.)

FIG. 7—STEEL COOLED SLOWLY FROM 650 TO 1,200 DEGREES FAHR.
(Magnified 250 diameters.)

microscope will tell us whether or not this heat treatment has performed its work as thoroughly as it should. If the structure of the casting, after its first solidification, is not excessively coarse, heating it slightly above its critical temperature, maintaining it there until the heat has penetrated to the most remote point, and then for about one-half hour thereafter, will produce the desired result. But, if the steel has been cast at an excessively high temperature, or if it cooled with unusual slowness through the first 200 or 300 degrees after solidification, or if, in any other way, an unusual coarse and open crystalline structure has been produced, the process of annealing described above, even if protracted beyond the time limits mentioned there, will not completely obliterate the coarse crystals. The large crystals will be broken up into smaller ones, it is true; nevertheless, a sort of skeleton work, showing indistinctly the boundaries of the previous large size crystals, will persist, and the steel will be somewhat below normal in strength and ductility, or both.

### Steel Samples.

This point will be well seen by reference to Figs. 1, 2 and 3. Fig. 1 shows fine-grained steel as produced by forging or rolling; Fig. 2 shows the same steel in a very coarse, crystalline state, while Fig. 3 shows the same steel after again reheating above its critical temperature. It will be seen that the large crystals are broken into smaller ones, but there still persists a skeleton work, showing the outline of some of the coarse grains.

Figs. 4, 5 and 6, on the other hand, show steel in a finely grained condition; the same steel with a coarse structure, and finally this coarse structure refined almost to its original condition.

In order that the steel, shown in Fig. 3, might be refined as completely as that shown in Fig. 6, two steps in the annealing would be necessary. The coarse-grained steel would first have to be heated for an hour or more after complete soaking at a temperature far above its critical temperature. This would produce a structure intermediate between that of Fig. 1 and Fig. 2, and would obliterate the skeleton work showing the outlines of the previous coarse crystals. Such a casting must then be cooled to a black heat and subsequently reheated slightly above its critical temperature in order to give it the best possible physical qualities. This double process, of course, involves a waste of time, heat and labor and the bad quality of the coarse structured steel may not always be bad enough to justify this expenditure; but it should be remembered that this double process—and this alone—can redeem steel castings of extraordinarily coarse crystalline structure.

### Slow Cooling.

Another point about the annealing of steel castings which is not often emphasized is that slow cooling through that limited interval of temperature known as the *critical range* is detrimental to both strength and ductility. Slow cooling below 1,200 degrees Fahr. will improve the ductility of the metal, but slow cooling from 1,700 down to 1,200 degrees Fahr. develops thicker grains of ferrite and cementite and reduces both strength and ductility. Fig. 7 shows the structure of steel which has been cooled very slowly through this interval, and illustrates the fact to which I have alluded. Fig. 8 shows the critical range of steel and iron. Most of our

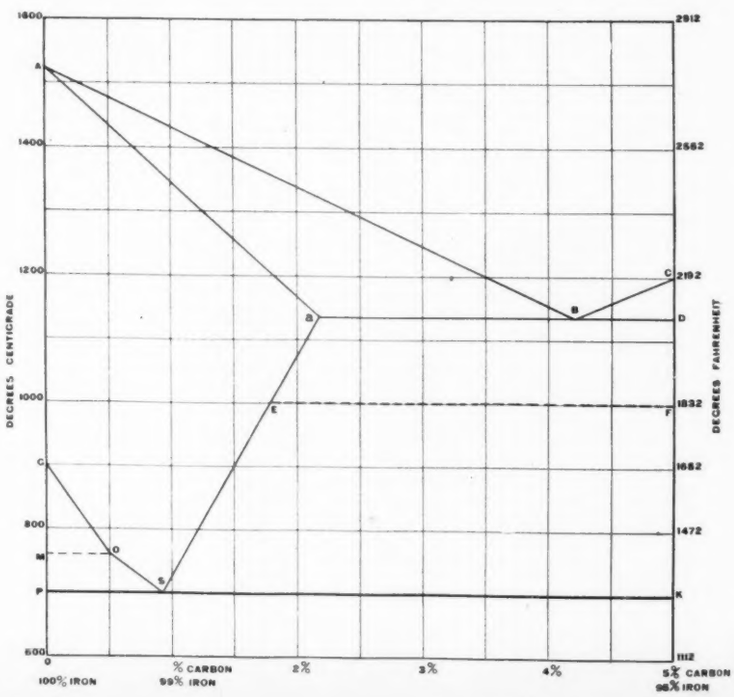


FIG. 8—DIAGRAM SHOWING THE CRITICAL RANGES OF IRON AND STEEL

steel castings contain less than 0.50 per cent carbon and, therefore, the critical temperatures above which they are to be heated are located in the line, *GO*. To cool the steel slowly from above the line, *GO*, to below the line, *PSK*, will develop thick crystals of ferrite and cementite.

**Process of Annealing.**

Because of this circumstance, there has arisen a process of annealing which consists in maintaining the steel castings above their critical temperature about half an hour after they are completely soaked, then pulling them out so the air will blow upon them until they are black heat, after which they may or may not be returned to the furnace and allowed to cool as slowly as they will. Of course, it must be remembered that this method of annealing may set up strains in castings of very complicated shape, and the castings must also be so piled that they will not strain each other during the expansions and contractions which they undergo while cooling through the critical interval.

It may be of interest to foundrymen to know that Seger cones may be purchased from the chemical supply houses and elsewhere and serve a valuable purpose in annealing work. These Seger cones are little forms of clay, melting at a great variety of temperatures. If these cones be placed in a furnace along with the castings, their melting will show when any particular temperature is attained. It is also possible to put cones in different parts of the furnace to determine the uniformity of the heat.

An ordinary horseshoe magnet is a valuable adjunct in annealing steel castings, because castings of 0.50 per cent carbon and less, lose the power of attracting a magnet when they reach a temperature of 1,550 degrees Fahr., so that in this way we can check up the eye in estimating the temperature of the annealing furnace, and this is especially valuable, because this particular temperature, 1,550 degrees, is only a short distance below the correct one for annealing.

# Small Steel Castings by Converter Process*

*By Bradley Stoughton*

THIS subject has been already discussed so thoroughly that not many points remain to be covered. One matter, however, which, it seems to me, has not been sufficiently exploited is that of silicon in the pig iron, which varies all the way from 1.50 per cent going into the cupola (equivalent to say 1.25 per cent in the melted pig) up to sometimes as much as 2.50 per cent. No doubt a greater proportion of silicon is required when only a few heats per day are made, as well as when the blowing is slow, and when the metal is retained a long time in the converter, being poured into hand ladles, requiring 30 minutes or so per heat. In our opinion, hotter steel and less loss may be obtained by rapid working and lower silicon, not more than 1.75 to 1.50 per cent in the cupola.

**Waste of Metal.**

Silicon has a treble effect in causing waste of metal:

1.—It is the slag producer of the process. Every unit of silicon present is oxidized, enters the slag and remains there permanently. In this respect silicon differs from iron, manganese and other elements that are oxidized, all of which may be afterwards partly reduced by the carbon and given back to the metal. Side blow converter slags are composed chiefly of silica and oxide of iron with a certain amount of manganese, depending upon the manganese in the pig iron used. It will have been noticed by all those accustomed to have these slags analyzed, that every type of practice automatically produces a slag of a certain analysis in iron. Colder blows may increase the amount of iron in the slag, and vice versa, but as a general thing, the iron content of the slag is approximately uniform, and therefore, the weight of slag will determine the weight of iron lost in it. For example, if a slag normally contains 30 per cent of iron and weighs 10 per cent of the bath, then the amount of iron lost in the slag will be, 30 per cent by 10 per cent equals 3 per cent of the total metal present. If, on the other hand, a slag weighs 15 per cent of the bath, and contains 30 per cent iron, then the corresponding metal loss will be, 30 per cent by 15 per cent equals 4½ per cent. The amount of slag produced is an important cause of waste of iron.

2. — A second source of loss due to silicon is increasing the length of the blow, and especially the interval before the carbon begins to burn. During this interval there is a large amount of brown smoke formed in the converter, all of which represents loss of iron by oxidation and volatilization. The longer this action continues, the greater will naturally be the iron wasted by this means.

3.—Finally, all the silicon introduced with the pig iron is burned up, and this likewise represents a loss of weight.

We are also in favor of rapid working as a cause of hotter steel, lower cost for labor, less loss in skulls, etc. It would seem that every plant should aim to produce at least three blows per hour, and at the rate of not less than 12 blows between 1 p. m. and 4:45 p. m.

**Success of Converter Plants.**

A good deal has been said and written about the many failures of converter steel foundries in this country, which have been all too frequent. The converter process has naturally had to bear the blame for these failures, but we think that the causes lie deeper than the process itself. A converter foundry is almost foredoomed to failure if it attempts to compete in an open market with the open-hearth process in castings averaging over 100 pounds each. The converter cannot hope to make large castings at as low a price as the open-hearth furnace. It can make small castings at a cheaper price than the open-hearth furnace, and can get a better price for them on account of greater freedom from blowholes, and better appearance and detail. This high price is necessary for the success of a converter foundry, however, because an open-hearth foundry will usually underbid the price on small castings for one or both of two reasons:

1.—An open-hearth foundry with large production can afford to lose money on a comparatively small amount of castings for the sake of other business.

2.—Open-hearth foundries, frequently, do not know how much their small castings cost them, because they do not segregate the small castings from the large and estimate separately the percentage of defective castings, which is what runs the price up to such a high figure in open-hearth practice.

In making a comparatively small tonnage of small size castings, the percentage of defective castings in this class may be as high as 20 per cent without this fact becoming evident on the daily or monthly statement, except occasionally by accident.

**Insufficient Capital.**

Another frequent cause of failure of converter foundries is lack of sufficient capital with which to do business on a business basis. The cost of installation of a converter foundry is so small that many companies rush in with small

*Presented at the Pittsburg convention of the American Foundrymen's Association.

capital. This has happened so frequently that buyers of steel castings are always ready and prepared to take advantage of the opportunity and they soon learn it when a foundry is in difficulties and is ready to accept work at low prices for the sake of quick cash. More often than not, the final result is failure and abandonment after a few months' struggle, but unfortunately there are usually enough of these tottering companies in the field to keep the market for small castings in a disorganized condition to the serious detriment of the business. This is not real competition and in the end will drain the strength of the industry as a whole.

It would seem that both open-hearth and converter foundries could serve their own interest best by agreeing to divide the field on a logical basis, each process confining itself to the class of casting which it can make to the best advantage. It seems to be now pretty generally admitted that the converter can make small castings of higher quality as regards freedom from blow-holes than the open-hearth furnace, either acid or basic.

We think also that if open-hearth foundries will take the trouble to figure their defective castings in small sizes separate and apart from their general run of castings, they will find the percentage so high that the cost of making them is seen to be greater than if they put up a converter for the purpose or else sublet the work to a converter foundry. On the other hand, a converter foundry cannot make large size castings so as to compete on a fair basis with the open-hearth process and attempts to do so can hardly serve the lasting advantage of either manager or stockholders.

# A Continuous Coremaking Process

SINCE the cost of non-productive labor in the core room of the average foundry exceeds the cost of the labor that is directly productive, it is evident that some radical changes are imperative. Such a change has been made in a large eastern foundry, and a large saving secured, by the use of properly adapted machinery and an arrangement of work benches and conveyors that ends the usual and wasteful walking to and fro of the workmen. Various elementary labor-saving devices in connection with coremaking have been adopted from time to time, such as power sand sifters, power mixers, multiple core boxes, mechanical squeezers or ramming machines, etc., and some attempts have been made to save labor in handling cores to and from ovens and storage racks, by the installation of continuous ovens. All of these measures have met with some success, though lacking in elasticity, as well as other essential features. But the increasing size of foundries has made it worth while for the engineer to study the problems offered. A plant embodying many novel features, from plans by Mr. Hooper, of the Hooper-Falkenau Engineering Co., New York, has lately been put in operation, and has done its work with satisfactory speed and good economy.

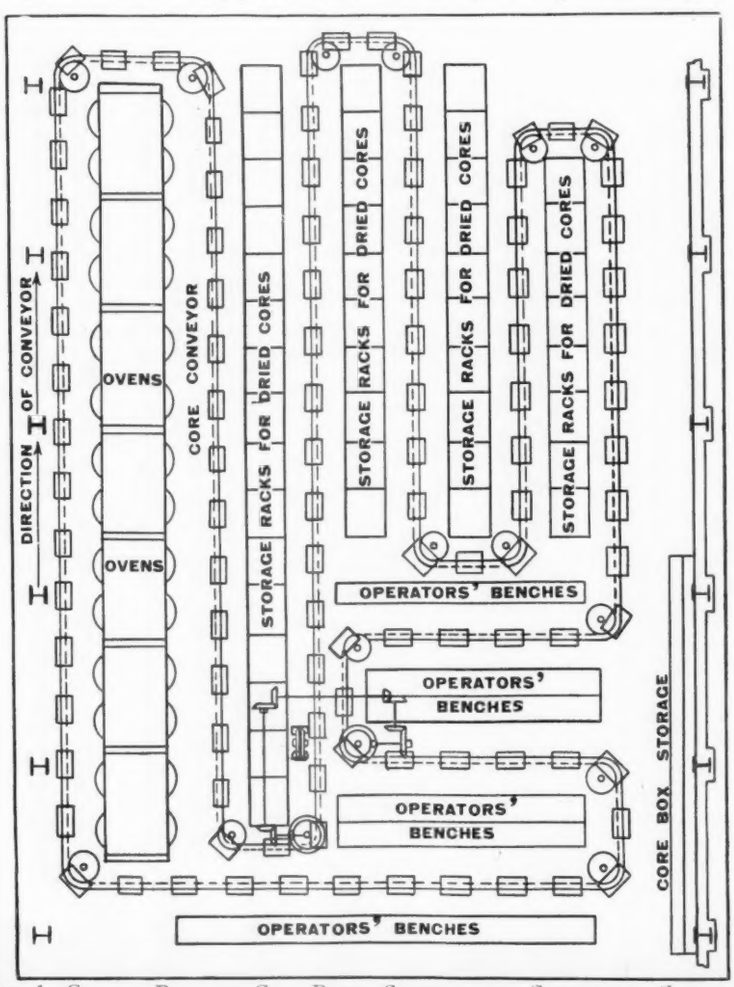


FIG. 1—GROUND PLAN OF CORE ROOM, SHOWING THE CONTINUOUS CONVEYORS AND CORE OVENS

### The System.

The process begins with the raw sand brought by conveyor from the storage bin into which it has been dumped directly from the cars. This conveyor delivers the sand directly into a drier, beneath which is a storage bin, which in turn discharges directly into a batch mixer beneath it. At the side of the batch mixer are a measuring pump for oil and the water and oil valves, all operated by the laborer who handles the mixer. The mixer discharges into a belt elevator provided at its upper end with a swinging spout, which discharges different mixtures into separate bins. From the bottom of these bins the various mixtures are dropped into a barrow, which runs on an elevated platform above the coremakers' benches. Above each bench and extending to within a few inches of it, is a galvanized chute open at the lower end. The mixed sand that is poured into this chute forms of itself a natural stop, the mixture flowing down as the pile at the bottom diminishes through use. So far there is little out of the ordinary save the use of the drier; although it may be noted here that two laborers handle easily all of the work and could probably handle a tonnage half again as large with no over-exertion.

### Core Conveyor.

For the next stages of coremaking, however, a number of unique features are in use, as shown in Figs. 1 and 2. Attention should first be given to the compactness of the general arrange-

ment, which places the coremakers' benches close to the battery of ovens, while near to both benches and ovens is a set of cooling and storage racks. Passing close to all of these in such manner as to serve them all is a conveyor consisting of cars of two shelves each, suspended at about bench height from an overhead rail, and pulled by means of a chain above and supported by the cars. This conveyor serves a number of operations. It carries green cores from the benches to the ovens, dried cores from the ovens to the cooling and storage racks, cores from the storage racks as desired to unloading stations, whence they may be carried to the molders and, finally, it returns core boxes, driers, and trays, to the coremakers' benches. This conveyor is of simple design, consumes but about two horsepower, and after a year or more of operation is declared to break fewer green and baked cores than hand transportation. Through its use the operative at any station does not leave his place. When the green cores are made, the drier, box or tray containing them is placed upon the carrier by the coremaker, who has merely to turn half-way around to do so. At the ovens the green cores are received by the oven attendants and placed directly upon the oven shelves awaiting them, the baked core being then placed upon the carrier for carriage to the storage racks, where they are taken from the driers, boxes, or trays, which latter are again placed upon the carrier to be returned to the core-making benches. If necessary, a station for washing and drying the trays and boxes can be established in the circuit at a convenient point ahead of the coremaking benches. The laborers at the racks also load cores, as desired, upon the carrier for delivery at unloading points along the line of the carrier whence they may be taken to the molders.

### The Ovens.

Since in this particular foundry there are nine different shapes and weights of cores to be dried, there being also four different mixtures, and a total production of about 30,000 cores per day, it will be recognized that a difference must be made in the baking of the several kinds of cores, while at the same time the continuity of operation of the system must be retained. The ovens, therefore, which are fired by oil, are built with independent circular shelves of varying sizes to accommodate the various cores, and the shelves are made of two sections separated by a baffle plate, which closes the ovens and forms the oven front. Thus one-half of the shelf is within the oven and half outside. Shelf room is thus always available for storing the green cores brought by the conveyor, this storing being in effect a new loading of the oven, since by revolving the shelf a half turn to withdraw the cooked cores, the half of the shelf that carries green cores is swung into the oven. Ventilating apparatus is provided consisting of hoods over the fronts of the ovens connected with exhaust apparatus. This removes the very disagreeable fumes arising from the baking of oil cores, and enables the oven chargers to work close to the ovens, as their duties require, without discomfort.

Service of over a year and a half has proved that this type of oven, works thoroughly well in connection with such a continuous system, there being no lack of capacity or accommodation for the variety of cores brought to the ovens.

It will be at once realized that the flexibility of this continuous system takes it out of the class of special apparatus and renders it available for any foundry having a sufficient tonnage. Size, shape, weight and mixture of cores are all readily and easily cared for by the conveyor and oven, while piecework rates for coremakers with day rates for oven tenders, storage rack laborers and mixing and distributing laborers give rise to no conflicts. There is no time wasted in passing between benches, ovens and racks. The system is thus adapted as perfectly to the jobbing, as to the specializing plant.

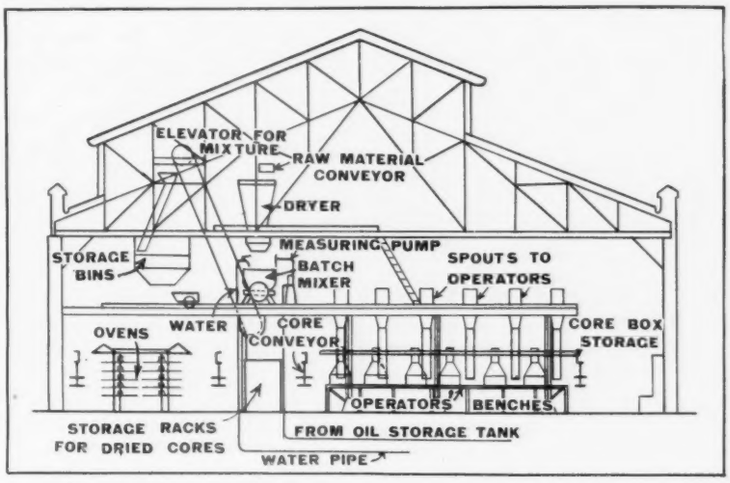


FIG. 2—SECTIONAL VIEW OF THE CONTINUOUS CORE SHOP

# Production of Malleable Castings

*By Donald M. Levy*

THE TWO processes in common use for the production of malleable castings are the English or pre-annealing process, and the American or black heart method. In the former process, owing to the oxidizing effect of the ore, there is a decrease in the carbon contents of the metal, but the actual changes in the carbon condition are in each case governed by the same general principles. The black heart process involves a change in the carbide condition and is, therefore, extensively used.

A white iron suitable for malleablizing may contain from 3 to 3.5 per cent carbon, almost all of which is in the combined form. The manganese, phosphorus and sulphur should be low, but a small quantity of silicon appears to be essential. The metal produces a casting with a white, crystalline fracture. In such an iron practically all of the carbon exists in the combined form. Iron which contains 3.5 per cent of carbon carries 52.2 per cent of iron carbide so that it is easy to understand why a material more than half of which is composed of such a hard and brittle constituent, should itself be distinguished by somewhat similar characteristics. If it were possible to decompose the whole of the carbide in white iron into its elements—free carbon and free iron—the effect of this change on the constitution and properties of the metal would be very marked, since instead of the 52.2 per cent of hard and brittle carbide there

is formed but 3.5 per cent of passive, free carbon and no less than 96.5 per cent of free iron, which is soft, ductile and easily workable. In cast irons of ordinary composition the proportion of free carbon is an index of softness. This is not because of any intrinsic softening influence, possessed by the carbon in this condition, but rather is an indication of the absence of a correspondingly large quantity of hard carbide, and the presence of a correspondingly large amount of free iron, to which is due the softness and ductility of the metal. Every 0.1 per cent of combined carbon which is transformed to free carbon represents not only the destruction of 1.5 per cent of carbide, but the liberation in its place of 1.4 per cent of soft and ductile free iron.

In making malleable iron, the ideal aimed at, is to change the white cast iron, by treatment, into a material which resembles wrought iron as closely as possible in its mechanical properties. If free carbon is to be left in the metal, it must be in such a condition as to have a minimum of weakening effect on the metal, and hence must be in as fine a form and distributed as uniformly as possible, since the coarser the graphite the greater is its destructive influence on the homogeneity and continuity of the iron. Any circumstance favoring the formation of coarse graphite is, therefore, undesirable. Therefore, the regulation of the physical condition of the free carbon is a point of great importance in the annealing process, and one in which microscopic study is likely to be of service.

### Effect of Impurities.

Since the ideal malleable casting approaches wrought iron as much as is economically and metallurgically practical, it is desirable to introduce as little impurity as possible into the raw material, for otherwise, unless the impurity can be eliminated during the annealing process, or its condition rendered harmless, the finished product will be of inferior quality. It is for this reason that phosphorus is not permissible in the white iron, since it is not eliminated by either process, and its destructive effects on the final product are well known. In the case of sulphur, its effect is to retard the desired changes in the black heart process, and as it is not eliminated, it is a dangerous constituent of a malleable casting, unless the moderate quantity allowed to be present is neutralized by manganese. Low sulphur is to be desired, and in the black heart process it is absolutely essential.

Silicon and manganese are chiefly considered from the standpoint of their influence on the process itself, since they are not eliminated to any great extent, and the effect in the finished product of the small quantities permissible in the white iron, is rather of secondary importance. Silicon, as is well known, has important influences on the carbon condition; in general, the temperature required for graphite separation is usually lowered, while at constant temperatures the rate at which precipitation is effected is increased progressively with the silicon content. From a study of the effects of silicon on the constituents of white irons and the manner in which it is distributed in them, it has been found that an iron carrying up to 0.8 per cent silicon is eminently suited for the annealing process. The fact that any considerable quantity of manganese has been proved capable of retaining about 2 per cent of the carbon in the combined form and of preventing its decomposition, will explain the desirability of reducing the amount of this element to moderate limits.

### Effect of Sulphur.

Sulphur, in its ultimate effect, tends to increase the stability of the carbides and to prevent or retard carbon precipitation, because the primary carbide, which is otherwise more liable to decomposition, is rendered more stable by its preferential association with the sulphide, while the secondary carbide, which is otherwise not so prone to decomposition, is more protected, indirectly, owing to the absence of free carbon which might otherwise promote decomposition by inoculation.

The English or ore annealing process has not received the same amount of study from the scientific point of view, as the black heart process, and the actions are rather more involved, since it not only effects the transformation of carbide to free carbon, but also the elimination of some of the carbon through the agency of the ore. The ore annealing process is particularly suited for white irons containing sulphur, since the influence of this imparity tends to prevent the carbon precipitation, which occurs in black heart annealing under these circumstances. In the treatment by hematite ore, carbon is, to some extent, eliminated independently of the sulphur, which, however, is also partly removed, and the quantity remaining is held to have a much less harmful effect than on a black heart casting, where only minute amounts of sulphur are permissible.

Recent research on a non-sulphur iron has indicated that a precipitation of carbon from the carbide is a preliminary to its removal in the ore annealing process, and that the malleablizing process proceeds in two stages, the first being carbon precipitation and the second, its elimination. It was also found that the whole of its action was not attributable to the action of the ore at its surface, but by action penetrating inwardly; in other words, the carbon did not travel to the oxidizer, but the oxidizer to the carbon, suggesting action by gases. It was assumed also, that the ore acted indirectly only, by supplying the oxidizing gas.

The ore is blackened, being partly reduced to lower oxides and partly to metal. It was found that ore heated alone gives up oxygen at temperatures of from 600 degrees Cent. upwards, lower oxides being produced. The liberated oxygen, it was suggested, oxidized the annealing carbon to carbon dioxide and when the oxygen was consumed, the carbon dioxide attacked more free carbon, forming carbon mon-oxide. The well-known iron reduction reaction then took place between the carbon mon-oxide and the hematite by which carbon dioxide was regenerated and some iron reduced from the ore; this carbon dioxide became available for further carbon oxidation, and by the gradual inwardly diffusing power of gases, the liberated carbon was gradually removed as the elimination proceeded inwardly. Checking up the gaseous pressures and analyses confirmed this hypothesis.

It is very probable that the processes involved in the production of some of the more sulphurous malleable castings is somewhat different and more complex than this. The oxide appears to absorb sulphur from the metal with which it is in immediate contact, and by this removal, the carbon change becomes possible within a restricted area, resulting in local deposition of annealing carbon, the removal of which by the oxygen and the carbonic acid can then proceed. The diffusive power of the sulphides in iron, proceeding outwardly, and the diffusion of the oxidizing gases, lead to a progressively thickening outward layer of malleable iron, enclosing a core in which sulphur and combined carbon may still remain in reduced quantity.

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## BOILING POINTS OF METALS.

In a paper presented at a meeting of the Faraday Society, London, Eng., H. Greenwood gave the boiling points of various metals at atmospheric pressure, as follows:

| | Degrees Cent. | Degrees Fahr. |
|---|---|---|
| Antimony | 1,440 | 2,624 |
| Bismuth | 1,420 | 2,558 |
| Copper | 2,310 | 4,190 |
| Lead | 1,525 | 2,777 |
| Magnesium | 1,120 | 2,048 |
| Silver | 1,925 | 3,497 |
| Tin | 2,275 | 4,127 |
| Aluminum | 1,800 | 3,252 |
| Chromium | 2,200 | 3,992 |
| Iron | 2,450 | 4,442 |
| Manganese | 1,900 | 3,452 |

# THE BRASS FOUNDRY

## Methods of Gating Bronze Castings

*By C. Vickers*

BRONZE possesses many peculiarities that affect its casting qualities and one of the most pronounced is its tendency to draw or shrink and to overcome this it is frequently necessary to construct the mold so as to overcome this difficulty. It might be assumed, for instance, that a good way to mold a bushing would be in a two-part flask, with the flange uppermost, this being the easiest way. Experience has taught, however, that this is not the best or even a good way to make bushings, as a draw or shrinkage is liable to occur in the casting at the junction of the flange with the cylindrical body, and for this reason it is always advisable to mold such castings with the flange down, as shown in Fig. 1. It should not be inferred that such castings cannot be made with the flange in the cope, as occasionally, apparently good castings are obtained in this way, but the percentage of defective castings will be much greater than when the method of molding with the flange down is adopted. The reason that the flange-down method produces superior results will become apparent from a consideration of what occurs while the metal is solidifying in the mold. After the mold has been filled with metal, the latter, in the process of cooling, reaches a stage where it is in a pasty condition and during this time and for some time after passing this point, it is very fragile and a comparatively slight strain will produce a rupture. When the flange is in the cope it cannot shrink towards the body of the bushing, as it is held by the ledge of sand where it overlaps the body. Consequently, the latter is held to the flange by the cohesion of the metal joining the two, and by its bearing at the other end, on the sand of the mold bottom.

If a contracting mold were used, which could follow-up the shrinkage of the casting, the cylindrical section would be steadily pushed up against the flange, and no separation would occur at this point. The mold, however, retains its original length, while the casting contracts, and, as it is impossible for the flange to move, the body of the casting must do so if the parts are to remain intact, and it must move upwards towards the flange, thereby leaving its support at the bottom of the mold and thus becoming entirely suspended from the flange. It will be apparent, therefore, that the chances are greatly in favor of a separation of the casting at the flange, particularly if it is a heavy one, as the weight of the metal in the body may be too much for the cohesion of the metal to sustain, and as the strain of suspension occurs at the junction of the body and flange, a separation occurs at this point, which manifests itself on the casting as a crack or shrink underneath the flange.

### Defects Caused by Gravity.

Such defects are usually attributed to shrinkage, as it is believed that the metal has drawn away at the flange, but this is not the case. While the shrinkage is a contributing cause by making the casting shorter than the mold, so that a condition of either suspension or rupture of the body occurs, the actual separation, when this happens, is caused by gravity. All danger of such defects is avoided by molding with the flange down, as in this case the force of gravity assists in holding the flange and body together, and the juncture of these two parts will invariably be sound. The same effect could, of course, be obtained by rolling over the mold immediately after it has been poured, when the flange is made in the cope. The application of this method, is, however, too limited to be considered seriously. When the flange is molded in the cope it is possible to obtain castings that are apparently sound, provided the metal is poured hot. In this case it is probable, that as the crack forms it is filled up by a seepage of metal from the flange and sprue, and this theory is supported by the fact that a casting of this shape, when molded flange uppermost, can be made to show a shrink or crack, if poured sufficiently cool.

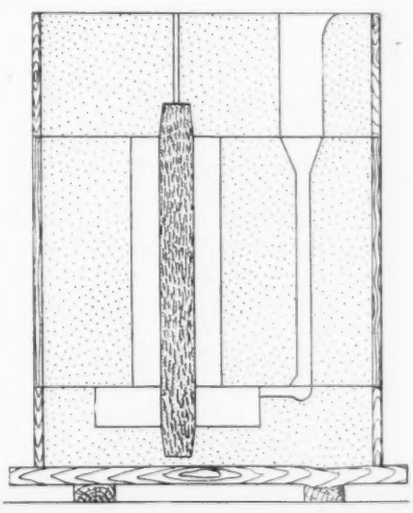


FIG. 1—METHOD OF GATING A FLANGED BUSHING TO BE CAST IN BRONZE

When the flange is molded down, more time is consumed in making the mold, but this can be greatly reduced by making the pattern with a loose flange, as shown in Fig. 4, as this will obviate the use of a match. When making the mold, the flange is placed on the follow-board with the recess down, the drag is rammed and rolled over and the joint is made. Then the body of the pattern is placed in position, the cheek is set onto the drag and rammed, after which the cope is closed over. It will be noted that the diameter of the gate is increased considerably where it passes through the cope, the object of the extra metal at this point being to provide a head that will act as a feeder, and thus prevent shrinkage or drawing, at or around the gate.

A longitudinal section of a mold for a bronze die blank is shown in Fig. 2, which illustrates the method of gating and feeding. It will be noted that the core is enveloped by a considerable thickness of metal, which will

make it necessary to protect it with a heavy coating of plumbago, to prevent penetration by the metal. This protective coating of plumbago should be applied to the core in the form of a paste, and not as a paint, and the best way to coat the cores is to apply the plumbago with the fingers, which produces a smooth, glossy coating, entirely impervious to the metal. In the case of cores of irregular shape it may sometimes be necessary to apply the plumbago, mixed to the consistency of cream, with a brush, but whenever possible, this method should be avoided, as when so applied, the coating is apt to flake off after it has been dried on the cores. This heavy coating of plumbago is not necessary on work of ordinary thickness where plumbago is used, but when the core is surrounded by a heavy mass of metal, it will be found that an ordinary coating of plumbago painted on, is useless, as the metal, especially when poured hot, will easily penetrate the plumbago, so that the space where the core has been, will be filled with a mingled mass of sand and metal. In all cases where it is found that the cores in heavy bronze castings *burn-in*, it will be helpful to coat them with plumbago by rubbing it on in the form of paste.

While on the subject of protecting cores from penetration by the metal, attention may be directed to that type of core, so frequently encountered, that has been made in halves and the pasted joint improperly closed. It is usually required for some hurry-up job, on which the time is limited and no opportunity is given to properly close the opening and dry the core in the oven. In such a case the joint can be closed by the application of plumbago made into a paste by mixing it with kerosene, and then rubbing the paste into the joint. The use of kerosene for making the plumbago paste is not advisable on ordinary work where the cores are put in stock, but only in cases where the molds are to be cast immediately, as otherwise, after the kerosene has evaporated, there is nothing to hold the plumbago on the core. For the usual run of cores, the plumbago is mixed with molasses or glue water, and of the two adhesives the latter is to be preferred.

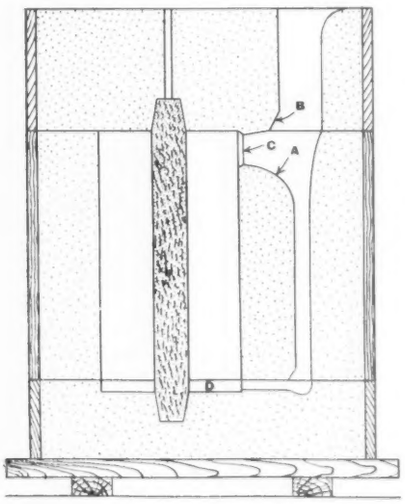



FIG. 2—METHOD OF GATING AND FEEDING A BRONZE DIE BLANK

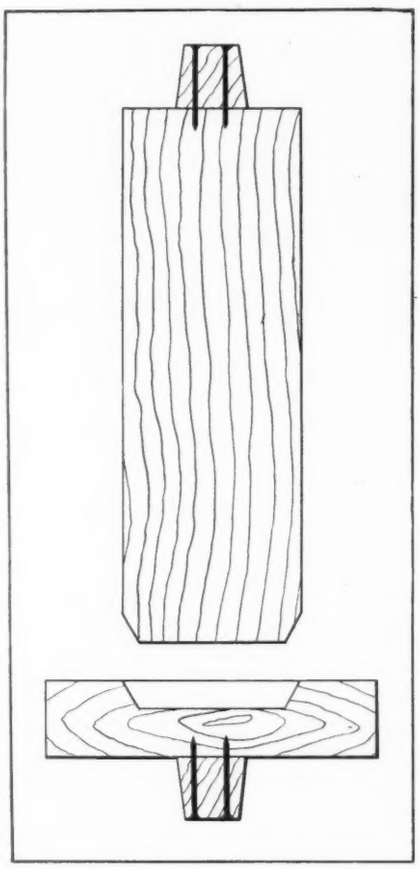


FIG. 4—A GOOD WAY TO LOCATE A LOOSE FLANGE ON A BUSHING PATTERN

### Melting the Metal.

Bronze die blanks are a class of castings that must be clean and free from defects. After being machined, they are engraved, often to a considerable depth, so that much loss and annoyance ensue when some hidden defect is encountered. These castings are frequently made from scrap metals, in which case it is not unusual that trouble is experienced from dross, invisible before a cut is taken off, or from porosity, which likewise cannot be detected until machine work has been done. To avoid these troubles selected scrap should only be used, and the method of selection, when external appearance of the piece of scrap fails as a guide, should be by an examination of the fracture of the metal. If the fracture reveals red or black particles, particularly the latter, the metal should be rejected, as it carries too much oxide to make clean castings. When the fracture is crystalline and the piece of scrap can be broken only with difficulty, the metal will usually be found to be clean and can be accepted as a fairly good metal suitable for the work in hand. This selected scrap should be melted carefully under a cover of charcoal. Carefulness in this case, consists of continually adding more metal as the charge sinks down and never permitting the metal to get beyond a semi-fluid state until the crucible is filled, when its contents should be thoroughly stirred to liberate and bring the dross to the surface. The deoxidizer is then added, the metal is stirred again and a cover of charcoal is thrown onto the bath. The furnace is heated strongly to raise the metal to the proper pouring temperature, which, in this case, is characterized by a bright appearance of the surface of the charge. Phosphorus as a deoxidizer is suitable for this work and is added in the proportion of 1 per cent of phosphor copper. It will be noted that the illustration of the die blank shows the mold gated both at the top and bottom, and attention is directed to the incline, *A*, Fig. 2. The object of this is to direct the metal downwardly to the bottom of the sprue, so that metal will not enter by the heavy gate at the top until the mold is nearly filled. When making the mold a part of the pattern is sunk into the drag, as at *D*, Fig. 2, which eliminates the necessity of inverting the cheek for the purpose of cutting the bottom gate. Mold-

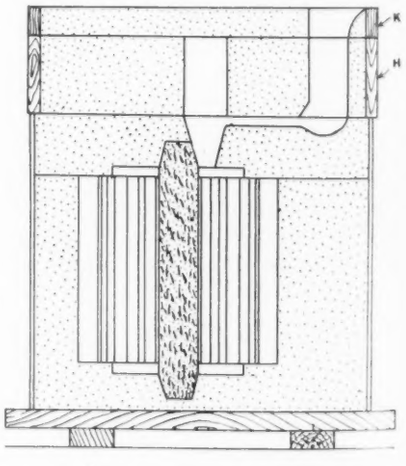



FIG. 3—A DROP GATE ON A BRONZE GEAR THAT AVOIDS SHRINK CAVITIES

ing will be greatly facilitated if this part of the pattern is made loose as in the case of the flange shown in Fig. 4. The heavy gate at the top of the casting is for feeding purposes and prevents shrinkage or sinking down of the upper part of the casting. The incline, *B*, also greatly aids the feeding down of metal from the sprue. The feeding gate is filleted as shown at *C*, so that it can be broken off the casting while the latter is hot, without tearing away a part of the casting. This method of molding has been in successful use for a number of years and clean castings are produced when the metal is selected, skillfully melted, and poured hot. When new metals are required an excellent alloy follows: Copper, 86 pounds; phosphor-copper, 1 pound; tin, 5 pounds; zinc, 4½ pounds, and lead, 3½ pounds.

A successful method of drop-gating a bronze gear is shown in Fig. 3. Occasionally gears are gated on the teeth, and frequently a horn gate is used, as drop-gating is not practiced to the same extent in brass as in iron foundries. Brass or bronze castings, when gated on the top frequently have shrink holes under the gate, which become visible when it is cut off and generally ruin the casting. By the method of gating shown in Fig. 3, this trouble is avoided. The drop gate is placed next to the core, is of large size, and does not cut through the cope, but forms a blind riser. This riser is connected to a pouring sprue by a channel cut in the top of the cope of the mold, and is covered by the frame, *H*, through which both the riser and the sprue are cut. The top of the riser is then covered by a second frame, *K*, through which the sprue only is carried. This method of gating will eliminate the shrinkage troubles experienced in casting bronze, and gives better results than when the drop gate is carried through the cope in the manner practiced in iron foundries.

# Corrosion of Brass Foundry Products*

*By William Vaughan*

THE term *corrosion* may be defined as "the effects produced upon a metal by the combined action of air and water, with or without the stimulus provided by the various impurities in the water or in the atmosphere." These corrosive effects are explained on the basis of: (1) Chemical action alone; (2) electro-chemical action, which may be caused by stray electrical currents from an outside source or by galvanic action due either to included impurities or to the varying proportion of the different elements constituting the alloy.

The main difference between two actions is in intensity; the corrosive action itself is practically the same in both cases, unless abnormal results are produced by high current densities. Effects that take months under the first can be accomplished in six or eight hours by the second. By accelerating the chemical action by an electric current, we have, therefore, a comparatively simple method of determining the relative resistance to corrosion of the various metals.

*Presented at the Pittsburg Convention of the American Brass Founders' Association.

### Studying Corrosion.

The methods of studying the corrosion of different alloys which naturally suggest themselves are: (1) Visual observation; (2) loss in weight method; (3) loss in weight and the analysis of the corrosion product. The first method consists of simply observing the action of different solutions, whether acid, alkaline or neutral, on metals of different composition. This is only a rough qualitative method and may be very misleading.

The loss in weight method consists of weighing the sample before beginning the experiment and again at the end of the experiment, taking care to remove all scale. The figures thus obtained give the loss of metal by corrosion or the percentage of corrosion. For example, practical experiments comparing the corrosive effects on various alloys of sulphite acid, such as is used in pulp mills, were carried out. The different alloys were placed on a piece of wood in a small digester, covering with sulphite acid and heated for three days at a temperature of 150 degrees Cent. The results obtained were as follows:

| Alloy | Original weight in grams | Weight after heating, grams | Loss in weight grams | Per cent loss |
|---|---|---|---|---|
| (1) | 190.372 | 184.300 | 6.072 | 3.189 |
| (2) | 179.937 | 178.750 | 1.187 | .659 |
| (3) | 123.222 | 120.210 | 3.012 | 2.444 |
| (4) | 96.496 | 96.480 | .016 | .016 |
| (5) | 100.889 | 99.930 | .959 | .955 |
| (6) | 89.195 | 84.900 | 4.295 | 4.81 |

(1) This sample dissolved rapidly and left a perfectly clean surface.

(2) This sample was covered with a heavy coat of copper sulphide, which formed a protecting film.

(3) Sample badly etched, no protective coating produced.

(4) A very thin protective film formed almost immediately.

(5) This metal also had a protecting film.

(6) Sample corroded very rapidly with no protecting coating.

By the third method, loss in weight and analysis of the corrosion product, not only the amount of corrosion, but also the actual percentage of each element corroded can be determined. It is by this method that some of the

**Table I.**

BRONZE.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 95 | 0.3787 | 0.3638 | 96.07 |
| 85 | 0.1289 | 0.1245 | 97.03 |
| 75 | 0.0416 | 0.0400 | 96.1 |
| 65 | 0.0061 | 0.0036 | ..... |
| 55 | 0.0037 | 0.0030 | ..... |
| 45 | 0.0049 | 0.0039 | ..... |
| 35 | 0.0410 | 0.0126 | 30.1 |
| 25 | 0.1579 | 0.0213 | 3.3 |
| 15 | 0.2629 | 0.0224 | 8.5 |
| 5 | 0.3707 | 0.0121 | 3.2 |

**Table II.**

BRASS.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 93.6 | 0.1184 | 0.1069 | 90.3 |
| 86.6 | 0.1184 | 0.1012 | 85.5 |
| 83.6 | 0.1177 | 0.0888 | 75.5 |
| 73.4 | 0.1188 | 0.0845 | 71.2 |
| 60.3 | 0.1214 | 0.0688 | 56.7 |
| 51.3 | 0.1136 | 0.0357 | 31.4 |
| 47.6 | 0.1132 | 0.0015 | 1.33 |
| 22.6 | 0.1031 | 0.0010 | 0.97 |
| 10.5 | 0.1094 | 0.0003 | 0.28 |
| 3.1 | 0.1116 | 0.0002 | 0.18 |

**Table III.**

ALUMINUM BRONZE.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 96.0 | 0.3426 | 0.3220 | 94.00 |
| 86.4 | 0.2945 | 0.2713 | 86.01 |
| 76.0 | 0.1082 | 0.0667 | 61.7 |
| 65.4 | 0.0703 | 0.0460 | 63.0 |
| 55.0 | 0.0430 | 0.0196 | 43.00 |
| 45.6 | 0.0401 | 0.0161 | 40.14 |
| 35.2 | 0.0352 | 0.0134 | 38.08 |
| 25.0 | 0.0364 | 0.0123 | 33.79 |
| 15.1 | 0.0408 | 0.0114 | 27.94 |
| 10.0 | 0.0451 | 0.0125 | 27.71 |

**Table IV.**

BRONZE.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 95 | 0.2528 | 0.2452 | 97.0 |
| 85 | 0.2513 | 0.2471 | 92.0 |
| 75 | 0.1143 | 0.1000 | 98.2 |
| 65 | 0.0049 | 0.0038 | ..... |
| 55 | 0.0037 | 0.0024 | ..... |
| 45 | 0.0027 | 0.0032 | ..... |
| 35 | 0.0491 | 0.0077 | 15.7 |
| 25 | 1.7904 | 0.3783 | 21.7 |
| 15 | 1.2990 | 0.1824 | 14.0 |
| 5 | 1.0752 | 0.0433 | 4.3 |

most valuable corrosion investigations have been carried out. By the electrolytic method, using low current densities, several investigators, Messrs. Curry, Lincoln and Rowland, have carefully worked out the effects of different solutions in the corrosion of different alloys. It may be of interest to compare some of these effects as gathered from the data compiled by these men, which are given in the accompanying tables.

Alloys of copper and tin; copper and zinc; copper, tin and zinc and copper and aluminum were tested ranging in composition of copper from 95 to 5 per cent. The effect of electrolytic corrosion of the bronzes was determined in 7 per cent solutions of sodium sulphate ($Na_2So_4$) sodium nitrate ($NaNO_3$), and sodium chloride (NaCl), using a current of 25 milliamperes, whereas the brasses were examined in normal solutions of these salts.

The amount of corrosion in the copper-tin bronzes of 95 and 90 per cent copper content is very heavy in sodium solution, Table I, and decreases rapidly until the 70 per cent alloy is reaehed. From 70 per cent to 40 per cent bronzes there is so little corrosion that the metal remains apparently unchanged, whereas the amount of corrosion from 35 per cent to 5 per cent again increases very rapidly.

The amount of corrosion in the copper-zinc brasses in sodium sulphate solution, Table II, is practically the same throughout the series, and the composition of the corrosion product is practically the same as the brass itself, from 93.6 to 51.3 per cent copper. Below 47.6 per cent the corrosion product consists mainly of zinc with very little copper.

The copper-tin-zinc brasses in the same solution corrode in a manner but slightly different from the straight brasses, except that there is a decrease in the amount of corrosion. Additions of small amounts of tin to an alloy affect the physical properties by increasing its hardness, rigidity, elasticity and tensile strength.

### Aluminum Bronzes.

The aluminum bronzes, Table III, in sodium sulphate solution dissolve almost according to their composition along the range from 95 to 60 per cent copper. From 55 per cent copper in the alloy to 35 per cent there is a gradual falling off in the amount of corrosion, whence it rises again as pure aluminum is approached.

The copper-tin bronzes, Table IV, in sodium nitrate solution act very much as they do in sodium sulphate, the 95 to 90 per cent bronzes dissolving very readily; the 85 to 70 per cent dissolve less easily on account of the protecting film that is formed. The 65 to 40 per cent bronzes are affected but little by the nitrate solutions, and the thin film that forms is not easily broken down. The 40 to 5 per cent bronzes all corrode, the corrosion being slight at the 40 per cent, and increasing rapidly as pure tin is approached, due probably to disintegration.

The amount of corrosion of the copper-zinc brasses, Table V, in the nitrate solution gradually increased with the decrease in the copper content until the 47.6 per cent brass is reached, when it falls off very rapidly to 22.6 per cent copper in the metal. From the 22.6 per cent brass to pure zinc the increase in the amount of corrosion is very marked. This seems to be due to the fact that some of the crystals dislodged by the body of the metal being dissolved away, thus leaving them to fall into the electrolyte.

The amount of corrosion in the 95 to 50 per cent brasses containing 1 per cent of tin is, in general, the same as that of the pure brasses, increasing slightly with the decrease in copper content. Tin was only added to brasses of high copper content, 95 to 50 per cent.

### Aluminum Bronze.

Aluminum bronze, Table VI, in sodium nitrate solution, showed that the 95 per cent bronze has the greatest solubility and this decreases slightly with the decrease in copper content to the 75 per cent bronze, whence it rises to the 65 per cent and remains almost constant to 55 per cent. From the 55 per cent bronze it decreases to the 25 per cent, and from there to pure aluminum the corrosion increases rapidly.

The copper-tin bronzes, Table VII, in sodium chloride solutions do not become passive as they do in the other solutions, Tables I and IV. There is a continuous changing in the amount of corrosion from 95 per cent copper in the sample to the 5 per cent copper.

The amount of corrosion in the

**Table V.**

BRASS.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 93.6 | 0.3091 | 0.2877 | 95.2 |
| 86.6 | 0.3191 | 0.2775 | 86.9 |
| 83.3 | 0.3173 | 0.2645 | 83.4 |
| 73.4 | 0.3325 | 0.2481 | 75.2 |
| 60.3 | 0.3452 | 0.2105 | 61.0 |
| 51.3 | 0.3375 | 0.1812 | 53.7 |
| 47.6 | 0.3504 | 0.1516 | 43.2 |
| 22.6 | 0.2352 | 0.0002 | 0.0 |
| 10.5 | 0.3316 | 0.0228 | 6.8 |
| 3.1 | 0.4804 | 0.0174 | 3.6 |

**Table VI.**

ALUMINUM BRONZE.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 96.0 | 0.2498 | 0.2440 | 97.60 |
| 86.4 | 0.2409 | 0.2151 | 89.29 |
| 76.0 | 0.0876 | 0.0642 | 73.29 |
| 72.4 | 0.1253 | 0.0908 | 72.46 |
| 55.0 | 0.0822 | 0.0460 | 55.90 |
| 45.6 | 0.0805 | 0.0242 | 30.06 |
| 35.2 | 0.0640 | 0.0217 | 33.91 |
| 25.0 | 0.0591 | 0.0141 | 23.06 |
| 15.1 | 0.0653 | 0.0129 | 19.75 |
| 10.0 | 0.0759 | 0.0123 | 16.21 |

**Table VII.**

BRONZE.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 95 | 0.3486 | 0.3318 | 94.9 |
| 85 | 0.3216 | 0.2775 | 86.3 |
| 75 | 0.2793 | 0.2694 | 75.4 |
| 65 | 0.2462 | 0.1611 | 65.4 |
| 55 | 0.2598 | 0.1402 | 54.0 |
| 45 | 0.4021 | 0.1802 | 44.8 |
| 35 | 0.3693 | 0.0525 | 14.2 |
| 25 | 0.3051 | 0.0584 | 19.1 |
| 15 | 0.4425 | 0.0448 | 10.1 |
| 5 | 0.4237 | 0.0169 | 3.8 |

**Table VIII.**

BRASS.

| Percentage of copper in test | Corrosion in grams. | Grams copper corroded. | Percentage of copper corroded. |
|---|---|---|---|
| 93.6 | 0.7204 | 0.6756 | 93.8 |
| 86.6 | 0.7165 | 0.6263 | 87.4 |
| 83.3 | 0.6925 | 0.4993 | 76.6 |
| 73.4 | 0.6460 | 0.5117 | 79.9 |
| 60.3 | 0.5773 | 0.3417 | 59.2 |
| 51.3 | 0.4618 | 0.0990 | 21.4 |
| 47.6 | 0.4077 | 0.0077 | 1.3 |
| 22.6 | 0.4042 | 0.0006 | 0.2 |
| 10.5 | 0.3975 | 0.0004 | 0.01 |
| 3.1 | 0.3972 | 0.0001 | 0.00 |

straight brasses, Table VIII, in sodium chloride solutions, decreases very rapidly with the decrease in copper down to about 50 per cent brass. From 50 per cent copper to pure zinc the amount of corrosion remains practically constant. On examining the corrosion product of the brasses of high copper content, 95 to 50 per cent, it was found to be a heavy, red scale which in most cases was easily removed. The precipitate on the brasses of low copper content was pure white, mostly zinc. When three-quarters to 1 per cent of tin was added to brasses they behaved almost exactly like the pure copper-zinc. Tin was only added to brasses from 95 to 50 per cent copper.

In this connection the experiments made by Lincoln on brasses using solutions of common salt, bath salt and synthetic sea salt indicated that they corroded practically alike and agreed with his former experiments with solutions of pure sodium chloride.

### Results Compared.

From these results we can compare not only the action of the same alloy in different solutions, but also the action of different alloys in the same solutions. Take for instance the corrosion of the copper-tin bronze in different salt solutions, Tables I, IV and VII. It is apparent that this composition is affected more in the sodium chloride than in either of the others. There is also a very striking difference in the way the brasses, Tables II, VI and VIII, act in different salt solutions. They are least affected by sodium sulphate.

A comparison of the different alloys in the same solution is interesting. Comparing the different alloys in the sulphate solution, Tables I, II and III, it is clear that the copper-tin bronze, Table I, is the least affected, and therefore the best to use in a solution of this kind.

Comparing Tables III, IV and V, the corrosion in sodium nitrate, we still find the copper-tin bronze the best metal to use, since there is practically no corrosion between 75 per cent and 40 per cent copper content.

The facts presented indicate that an accurate idea of the relative corrosion of alloys can be obtained by laboratory experiments. A large amount of experimental work still remains to be done on the numerous alloys which are manufactured today, but it is to be hoped that investigations will be carried out to such an extent that in the not distant future the employment of alloys, which are rapidly destroyed by corrosion will be due to carelessness or willful intention and not to lack of proper information.

# Vanadium in Copper Alloys

IN A paper presented recently at a meeting of the mining and metallurgical section of the Franklin Institute on "Vanadium Alloys," Geo. L. Norris states that vanadium has a very high electrical resistance and the addition of only a very few hundredths of a per cent greatly reduces the conductivity of copper. This small quantity, however, will increase the elastic limit, tensile strength and ductility of copper from 10 to 20 per cent. In a recent test of vanadium in common brass or Muntz metal containing copper 60 per cent, and zinc 40 per cent, the following results were obtained:

| | Without vanadium. | With trace of vanadium. |
|---|---|---|
| Ultimate strength, pounds per square inch..... | 38,000 | 49,000 |
| Elongation in 2 inches, per cent ..... | 28 | 45 |
| Reduction of area, per cent ..... | 30 | 42 |

The increase in resiliency by tests on notched bars was a little over 80 per cent. Tests of vanadium in manganese bronze gave the following results:

| | Manganese bronze. | Manganese bronze with vanadium. |
|---|---|---|
| Elastic limit, pounds, per square inch ..... | 30,560 | 50,560 |
| Ultimate strength, pounds, per square inch..... | 54,160 | 81,440 |
| Elongation in 2 inches, per cent ..... | 22 | 12 |
| Reduction of area, per cent ..... | 18 | 14 |

The composition of the two bronzes follows: Manganese bronze, copper, 58.81 per cent; zinc, 38.08 per cent; aluminum, 1.22 per cent; manganese, 0.69 per cent, and iron, 0.84 per cent; manganese-vanadium bronze, copper, 58.56 per cent; zinc, 38.54 per cent; aluminum, 1.48 per cent; manganese, 0.48 per cent; iron, 1 per cent, and vanadium, 0.03 per cent.

A large quantity of vanadium bronze is being made of a composition similar to manganese bronze but without manganese. This bronze is very strong, forges readily and resists corrosion to a very high degree. It is being used extensively for marine work, especially on torpedo and marine boats.

A vanadium bronze cylinder, 3 inches in diameter, 15 inches long with walls 9/16 inch thick has been successfully subjected to 9,000 pounds hydraulic pressure. The strength of the cast bronze is as follows: Elastic limit, 28,500 pounds per square inch; ultimate strength, 71,000 pounds per square inch; elongation in 2 inches, 32 per cent, and reduction of area, 27.8 per cent. Aluminum and vanadium readily alloy and an alloy containing 1 per cent of vanadium made by Heloise had a tensile strength of 24,174 pounds per square inch. The principal application of alumino-vanadium will be as a means of introducing vanadium into aluminum castings and recent experiments have shown that an alloy to be added to the aluminum, containing from 5 to 10 per cent vanadium will prove satisfactory for this purpose. There is every indication that the use of vanadium in aluminum alloys will very considerably increase the strength of the castings.

# Brass Foundry Difficulties

SOLVED BY EXPERTS

## Utilization of Skimmings

*What is the best method of utilizing washed skimmings? We have always attempted to ingot the recovered metal, but this method of procedure not only entails much work, but all the brass is not reclaimed, as a considerable quantity remains embedded in the slag in the form of shot and cannot be recovered unless the slag is pulverized so that the brass can be screened out. As the slag is exceedingly hard, we find that it does not pay to do this on account of the labor involved.*

There is not very much choice in the manner of utilizing skimmings. They can be satisfactorily employed as a covering on every pot of metal, charging about five pounds with each melt. To produce a fluid slag that will cover the surface of the metal in the same manner as glass, it is advisable to use a small amount of soda ash with skimmings utilized as a covering. When used in this way, the iron must be removed from the skimmings, as this metal will ruin the heats to which the skimmings are added as the color of the castings may be injuriously affected. The usual way of disposing of skimmings, however, is to run them into ingots. For this purpose old crucibles can be used that are considered too dangerous for another regular heat, and it is surprising how many heats of skimmings can sometimes be obtained from a crucible after it has been relegated to the discard, provided of course it is not a *leaker*. It requires a hot fire to melt the skimmings, and when the pot is charged, soda ash or plaster of paris should be used as a flux to thin the slag so that the brass can pass through it and collect at the bottom of the pot. It all depends upon the condition of the crucible whether it is advisable to make further additions after the first charge has melted. If the crucible is in good condition after the first charge has melted, the fluid slag on top of the metal can be swabbed off, using a suitably shaped iron skimmer, and the pot is again filled with skimmings. This process is repeated until the pot is nearly full of recovered metal. On the other hand, the crucible can be removed from the furnace when the first charge is melted and the metal can be cast into ingots. When the skimmings accumulate in large quantities, an open-flame furnace will be found more economical than a crucible furnace for reclaiming the metal.

## Alloying Nickel and Copper

*We have experienced considerable trouble in making a white metal mixture of approximately equal parts of nickel and copper. We find it very difficult to melt the nickel, although we are able to raise it to a white heat and have kept it at that temperature for several hours without melting it. Our melting equipment consists of ordinary straight shaft, coke-burning furnaces, and the draft is very good. Occasionally we succeed in making the alloy, and on such occasions the nickel reaches the pasty stage, when we pour the melted copper into it. The greater part of the castings poured, however, are misrun. Can you suggest anything that will help us out of our difficulty?*

Nickel has a very high melting point and your failure to melt it is due to the fact that your furnaces, even though they raise it to a white heat, fall a little short of the temperature necessary to melt the nickel. On occasions when you succeed in melting the nickel the furnaces work better, which is due to favorable atmospheric conditions, and if the stack is sheet iron, investigation, probably, will show that it rained on these days. The nickel can be melted, however, in these furnaces if the operation is properly carried out, and the method differs somewhat from the practice with copper. The first requisite is to stand the crucible on a base the same size as the bottom of the pot. This base is covered with a layer of silica sand. After charging the metal, place a cover provided with an observation hole on the crucible and coke-up, entirely burying the pot. Seal the cover of the furnace with sand and when the coke on top of the furnace becomes cherry red, a white heat will have been attained around the sides of the crucible and some of the coke will have been burnt away. The reserve supply of coke on top of the furnace is then poked down, the furnace being uncovered sufficient only to admit the poker. After re-coking, fresh coke is again thrown on top of the pot. After two or three re-cokings, the metal will be found to be liquid. For making the alloy mentioned, however, it is not necessary to go to all this trouble, because if the nickel and the copper are charged together the copper, when melted, will dissolve the nickel and will form an alloy therewith. It is entirely unnecessary to try to melt the nickel first, and it is poor practice to keep it in the furnace for several hours at a white heat. The copper-nickel charge will require more time to melt than copper alone, but melt it as quickly as possible by forcing the furnace, and when the charge is melted, add 2 per cent of manganese-copper and four ounces of aluminum.

## Honeycombed Brass Castings

*We are making a number of brass sleeves weighing from 30 to 75 pounds each. They vary in length from six to 18 inches and in diameter, from six to eight inches. The castings are honeycombed and our foreman is unable to account for this trouble. We cast the bushings on end in green sand molds, which are brushed with plumbago, and the latter is also used on the cores in the form of a wash. The metal is melted in natural draft furnaces under charcoal, and we are careful not to pour too hot. Scrap brass is used, and also new metal of the following composition: Copper, 84 pounds; tin, 8 pounds, and lead, 8 pounds.*

The cause of this difficulty lies in the manner in which the metal is melted. The use of charcoal, while highly commendable and even necessary, is not an absolute preventive against spongy castings unless other precautions, equally as important, are observed in the melting. While all spongy castings are not due to defective melting, by far the greater percentage of them are. Pin holes may be due to other causes, such as hard ramming, lack of venting, and

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

## FORMULAS FOR THE BRASS FOUNDRYMAN.

**Deoxidizing. Elements for Use in Copper and its Alloys.**

ALUMINUM.

This metal can be used in the production of copper castings to prevent porosity, the amount to be added varying from one-half to one per cent. The castings are, however, liable to run drossy.

ALUMINUM IN YELLOW BRASS.

Yellow brass is greatly improved for many purposes by the addition of aluminum, the amount to be added varying from one to six ounces per 100 pounds of metal. The brass is deoxidized and strengthened, its fluidity is greatly increased, and the zinc oxide smoke is greatly reduced. Aluminum in this connection is most valuable in the case of light castings, as it adds to the certainty with which the metal can be poured, and owing to the increase in fluidity the loss from misrun castings is considerably reduced. The metal should be poured as cool as is consistent with running the castings, and it must enter the mold without agitation, to prevent the formation of dross.

BORON.

The use of boron as a deoxidizer of copper is quite recent, and it can now be obtained commercially. The amorphous variety is used to make solid copper castings in the proportion of 1 per cent. As the boron passes into the slag the copper is left in a state of purity, and the resulting castings possess high electric conductivity.

CALCIUM.

Calcium is a powerful deoxidizer of copper and its alloys. It has been little used for this purpose in the past, but as it is abundant and comparatively easy to produce, it only lacks the demand to make this element one of the most familiar and valuable allies of the brass foundryman.

CHROMIUM.

Chromium can be obtained in the form of chrome-copper which contains 10 per cent of chromium. It is not used to any extent in the production of copper castings, but to form a bronze, and can be added by means of the rich alloy of chromium and copper to bronze, or as follows:

| | Pounds. |
|---|---|
| Copper | 56 |
| Zinc | 40 |
| Tin | 1 |
| Aluminum | 1 |
| *Chromium chloride | 4 |

*The chromium chloride, four pounds, will impart two pounds of chromium to the mixture, making a 2 per cent chromium alloy.

Melt the zinc, add the aluminum and four pounds of chromium chloride, allow the metal to become hot, stir well and ingot. Melt the copper under charcoal and add the tin and prepared zinc, stirring thoroughly. The alloy will then contain 2 per cent of chromium.

DATA SHEET No. 97, THE FOUNDRY, SEPTEMBER, 1911.

## USEFUL FORMULAS FOR THE FOUNDRYMAN.

WAX VENTS FOR CORES.

Paraffine wax is largely used for making wax vents for cores, and two pounds of wax will make 35 feet of ¼-inch taper. The wax is first softened by being placed in warm water, so that it can be squeezed through the vent machine. While warm and soft, the tapers are coiled for convenient storage, and previous to use are softened by immersion in warm water.

COMPOSITION VENTS.

A composition of equal parts of beeswax and rosin also makes an excellent wax vent. The wax should be first melted, then the rosin added as a powder, the mixture being well stirred meanwhile. This composition does not soften the cores like pure wax, as the rosin hardens the core and corrects this fault of the wax. Paraffine wax may be substituted for the beeswax, but is not as good. When, however, it is necessary to use the harder wax, the tapers should be formed by dipping cotton wick into the melted paraffine as the composition is too brittle to use without support. When beeswax is used, the tapers can be formed by squeezing through a vent machine.

COATINGS FOR STEEL CORES.

Add shellac varnish to the regular plumbago core wash until the mixture is thick enough to form a thin and perfect coating on the steel when dipped. When dry, re-dip until the required thickness is obtained. Another method of preparing steel shapes for use as cores is to coat with linseed oil, and while wet, dust with dry, sharp sand, and bake in the oven. Silicate of sodium (water glass) has also been found of value as a coating for steel cores. When the steel is to be burnt onto cast iron, it is first coated with silicate of sodium, and while tacky is dusted with finely powdered ferro-manganese. Before being placed in the mold the treated steel is thoroughly dried.

FACING MIXTURE FOR SKIN DRIED MOLDS.

| | Parts. |
|---|---|
| Old molding sand | 12 |
| New molding sand | 6 |
| Lake sand | 2½ |
| Sea coal | 2 |
| Flour | ½ |

Mix thoroughly and wet with clear water until as damp as ordinary molding sand. When the mold is made, brush on dry plumbago and polish with the hand; then paint with molasses water and dry until a hard skin is formed.

DATA SHEET No. 98, THE FOUNDRY, SEPTEMBER, 1911.

wet sand. The egress of the steam is thereby prevented and it is dispersed throughout and retained in the metal. The holes thus created will be small, round and are generally located in the upper part of the castings, and are fittingly described as pin holes. Castings having thin flanges that rise into the cope are subject to this defect, and the remedy is found in softer ramming of the sand over the flanges and piercing the flange section of the mold with a needle vent. Honeycombing, however, is different and in ordinary alloys is caused by the expansion of gases that have been absorbed by the metal during the time it was exposed to heat. Although other gases, such as hydrogen and nitrogen in addition to oxygen are absorbed, the latter is undoubtedly the chief source of honeycombing troubles. It is well to bear in mind that it is not necessary for the copper to be melted in order to become oxidized, as copper wire held at a red heat and exposed to the atmosphere, scales and becomes brittle and worthless. This is a frequent occurrence in burning the insulation from copper wire, and may happen to ingot, and other large masses of copper while it is being melted. In this latter case the temperature of the furnace is not sufficiently high to rapidly melt the metal after it has attained a red heat, therefore, it oxidizes on the outside, and the oxide scales off and drops to the bottom of the crucible, to be absorbed by the metal as it melts. In the case of brass, the metal that is oxidized forms a shell that is more refractory than the metal. This shell retains the form of the original piece of metal, and in fact acts as a crucible for the metal in the interior, which melts, and when liquid, bursts through the shell and runs out, leaving the empty shell floating on top of the molten metal in the crucible. This shell is subsequently stirred into the metal, and the effect of a number of such shells, stirred into and absorbed by the metal, is to introduce sufficient oxygen to aerate the metal like yeast lightens bread. It is evident, therefore, that the metal should be melted as rapidly as possible, and should receive constant attention, whether brass or copper, in the one case to prevent the formation of shells of oxide, and in the other, the formation of scale.

If the furnaces do not melt rapidly enough increase the draft, but if this is not possible, dip the copper in thick lime wash, made with salt water, and dry before charging down. In the case of brass, oxidation is more often caused by neglect in a hot furnace, by charging a pot full of cold metal and letting it melt and become hot without attention. This should never be done, but on the contrary the metal should be under constant observation, and as soon as it commences to sink, cold metal should be charged on top until the pot is filled, when the metal will be barely liquid under its cover of charcoal. With a hot fire the metal is brought to the proper casting temperature as rapidly as possible. The observance of these precautions constitutes what is known as careful melting, and is the best possible insurance against spongy castings.

## Chill Casting Alloy

*Can you furnish us with a formula for a white metal that can be cast in metal molds, and which will be considerably harder than the lead or tin alloys usually employed? We have been informed that zinc alloys are used for this purpose, but have no idea how to make them.*

An alloy that would probably prove satisfactory, follows: Zinc, 90 pounds; copper, five pounds, and aluminum, five pounds. Melt one-half the zinc, add the copper preferably in sheet or wire form and heat until dissolved; then add the aluminum and when melted, charge the balance of the zinc at intervals that will allow of its being dissolved without chilling the metal already melted Stir thoroughly when the mixture is complete.

## Phosphor Bronze for Bearings

*Will you kindly furnish us with a formula for phosphor bronze suitable for bearings? We have some heavy castings of this type to make, and would like to obtain a mixture that is not too expensive, but possesses fairly good anti-friction qualities.*

We advise the use of the following alloy: Copper, 79 pounds, phosphor-copper, three pounds; tin, seven pounds, and lead, 11 pounds. Melt the copper under charcoal, add the phosphor-copper, allow it to dissolve, then add the tin and lastly the lead. Stir thoroughly, and avoid pouring the metal at a high temperature. The well known mixture, 88-10-10, can also be used either with, or without phosphorus. To convert it into a phosphor bronze change the formula as follows: Copper, 77 pounds; phosphor-copper, three pounds; tin, 10 pounds, and lead, 10 pounds. If a cheaper alloy is desired, we suggest the following: Copper, 74 pounds; manganese-copper, one pound; tin, five pounds and lead, 20 pounds. Mix together in the order named. Both the manganese and phosphor-copper should be of the 30 per cent grades.

## Brazing Metal

*We are making cylindrical bronze castings weighing about 125 pounds and varying in thickness from 3/8 to two inches. The castings have heavy projections, which are bored so that pipes can be fitted and brazed on, the castings being heated a cherry red. This is where our trouble occurs. We place risers, 10 inches high and of the same diameter, on top of these projections and flow off about 75 pounds of metal to make them solid. We have used two different formulas for these castings, as follows: Copper, 88 pounds; tin, eight pounds; zinc, two pounds; phosphor tin, two pounds, and a small amount of phosphor-copper; another mixture used contains copper, 88 pounds; tin, nine pounds; zinc, two pounds; phosphor tin, two pounds, and four inches of stick phosphorus. We would like to make these castings in red brass and desire to obtain a suitable formula.*

You do not definitely state what the difficulty is and it might be assumed that the metal does not stand up under the brazing test, but crumbles away. No doubt this is just what occurs, but it might also be inferred that the projections on the castings were unsound when bored out and that is why the risers are used and such a large amount of metal is flowed-off. In this latter cast the difficulty can not be due to shrinkage as the risers are ample in size, so we are inclined to believe that the trouble is due to the metal and that in spite of the large amount of phosphorus used and careful melting, it is oxidized in the furnace. We would suggest that you omit the zinc in this alloy and if it is desirable to use phosphor bronze again, try the following alloy: Copper, 90 pounds; tin, five pounds and phosphor tin, five pounds. An alloy known as brazing metal, it seems to us, would give better results in this work, such for instance as the following: Copper, 86 pounds; zinc, 12 pounds, and lead, two pounds. A red metal follows: Copper, 85 pounds; zinc, 10 pounds; tin, three pounds, and lead, two pounds.

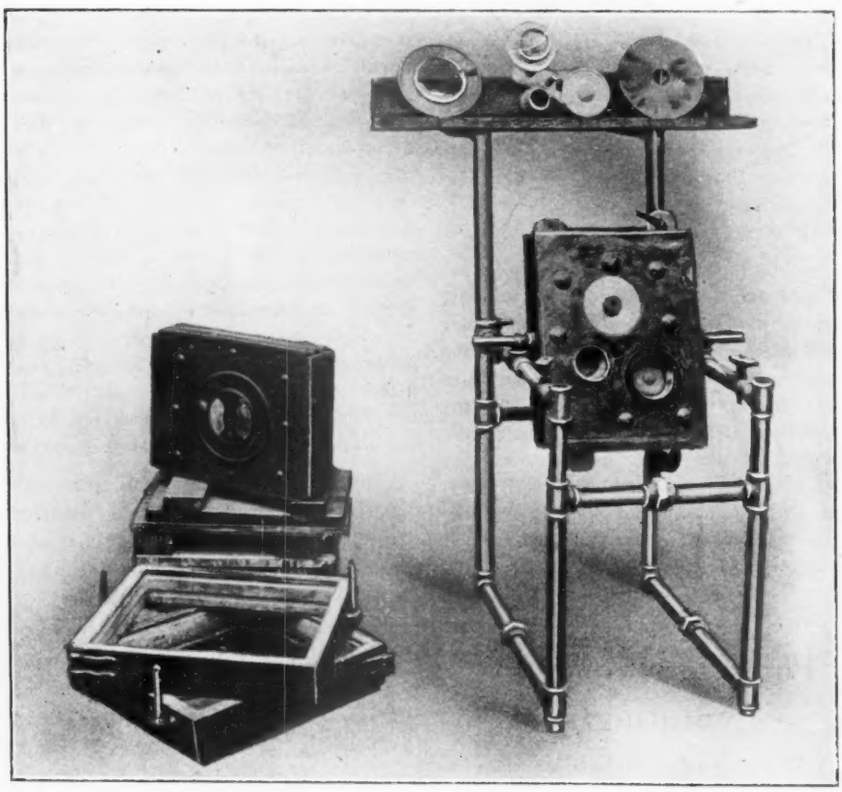
# The Development of the Match-plate

*By J. T. Peet*

LATE in the 50's, before the civil war, there wandered into Cincinnati, then an important stove manufacturing center, an Englishman, Wm. Batty, who had an idea then in advance of the times, but which has since taken definite shape and has become an important factor in foundry practice. Batty introduced what he termed the non-shrinkable match-plate. The writer, then only a boy apprentice in the same shop, distinctly recalls the enthusiasm of "Bill" Batty, who in time introduced a large number of these plates, cast from an alloy of spelter and antimony. This alloy was claimed to be, and was to some extent, non-shrinkable. The plates, however, were heavy and clumsy and so both Batty and his plates were forgotten. The writer, although then only an apprentice, continued Batty's match-plate work, but it was decided to make them of cast iron with due allowance for shrinkage.

Being unable to again interest foundrymen, the writer, of his own accord, manufactured a line of marketable match-plates for which there was a heavy demand. These match-plates were sold in competition with plates as usually made in the foundry, despite the fact that the cost of melted iron and floor room averaged $80 per ton. As these plates were also heavy and clumsy, the writer devised and patented a method of manipulating them, whereby the weight was made a negligible quantity, and to some extent an advantage. The machine on which these plates were mounted was patented Nov. 2, 1875, and was entitled "A Machine for Manipulating Molders' Match-Plates." The machine was introduced in a foundry where it was satisfactorily operated and greatly increased the output of molds made in the ordinary manner.

The apprentice boy had now grown to manhood and as his invention had qualities which attracted the attention of a neighboring foundryman, he was engaged to take full charge of the latter's shop and here he found the opportunity to further develop his invention, confining his efforts mainly to stove legs, then the *bugbear* of all foundries. The member of the firm who had managed the foundry, a far-seeing and ingenious man, allowed the match-plate wide latitude, but at the same time he was very conservative along financial lines and objected to making a line of new flasks to fit the plates. A plan, therefore, was devised whereby the plates were made to conform to the cut of the flasks on hand. This was accomplished by making a frame which was used by the molder and which had the required conformation, and building the sand to it. This was quite a step in advance, as prior to this time, loose wooden strips, of suitable thickness, were used. This frame was provided with pin holes and also the journal by which the completed plate was swung in the machine.



CONCRETE MATCH-PLATE AND MATCH-PLATE FRAME

### Concrete Plates.

Thus we see that about all that is now claimed in the process of making match-plates had a vogue and even more, for there is a distinct advantage in swinging the match-plate on journals instead of folding it back, as is done at the present time. Therefore, there is not so much that may be truthfully claimed is new in match-plate practice, except the use of aluminum, which greatly reduces the weight. And now comes a substitute for aluminum in the form of concrete plates, four or more inches in thickness, with the original patterns adhering, a very great advantage as all foundrymen know, each half of the flask handled separately, and the plate not at all. Surely this is the concrete age.

In the accompanying illustration is shown a concrete match-plate, 4 inches thick, with patterns adhering, and a tablet taken from its frame. This frame consists of four plates, bolted at the corners, with a journal which may be a piece of gas pipe extending through the concrete and across the frame, a sleeve being provided to permit of withdrawing the journal when releasing the tablet. The advantage of having a removable frame for a variety of plates is apparent. The adhering patterns may be removed at any time for alterations and may afterward be sweated back upon a film of beeswax which holds them securely. An application of gasoline will release the most delicate patterns without injury and only the customary care in handling that fluid is required.

The original machine, for which the bench shown is only a substitute, gripped the plate automatically when descending to withdraw the patterns, while the frame illustrated is provided with fingers which are thrown in position to engage the match-plate while the mold is being rammed. The pins on the flask are the usual length and do not pass through the holes of one-half of the flask, as they are so arranged that but one-half of the flask is molded at a time. The castings shown on the shelf above the frame were cast in molds made by the use of concrete match-plates.

# LATTER-DAY PATTERN SHOP PRACTICE--II*

## The use of hard sand and aluminum match-plates and vibrator frames --- Patterns for textile machinery

*By W. S. Giele*

THE manufacturers of molding machine equipment have been relied on, to some extent, for data in connection with the special adaptation of pattern equipment for use on molding machines. The use of the vibrator to assist in drawing the pattern is quite general. The vibrator does not appreciably enlarge the mold, but simply overcomes the friction of the pattern against the sand and consequently, while a pattern without any draft can be drawn perfectly, care should be taken that there is no back draft. The method of mounting patterns for use on power-squeezing machines, described, is that practiced by the Tabor Mfg. Co., Philadelphia.

### Vibrator Frame.

To properly suspend a pattern in a vibrator frame, a carrier of sheet brass, ⅛ inch thick, is fastened to the pattern or gate of patterns. The way in which this carrier is fastened must depend upon conditions, soldering or sweating, however, being the most common practice. In putting a carrier on a gate of patterns, it is desirable, if possible, to attach the carrier to the runner, as this will eliminate some grinding of the castings, and if the patterns are light, will allow a slight spring of the patterns in the match when ramming the drag, thus preventing the springing of the pattern when the cope is rammed on the drag.

The next operation is to locate carriers in the slot of the vibrator frame to meet those fastened on the patterns. These carriers should be rigidly fastened, but also should be easily removable. To accomplish this, after the carrier has been inserted in the slot in the vibrator frame, two 3/16-inch holes are drilled through both frame and carrier, and a brass pin is snugly driven into each, but not riveted over.

Holes are drilled in the carriers on the pattern, and the pattern is put in the vibrator frame, all carriers meeting, and the place to drill the carriers in the frame is marked with a scribe from the holes already drilled in the carriers on the patterns.

This method has been found much quicker than clamping the carriers together and drilling through both at once, and at the same time is sufficiently accurate for the purpose. The slot in the vibrator frame should be filled with wax to prevent the crumbling of the mold at the edges.

Put the vibrator frame into the cope flask, ram up and make the parting in green sand. Use lycopodium on the parting between the green sand and the match preparation. Set the match frame, which should be beveled to hold the match in place, over the pattern as parted, and clamp it in place so it cannot move when the match is rammed. For the match compound, pass 15 pounds of new burnt molding sand through a No. 30 sieve, and into this knead one quart of boiled linseed oil, to which has been added four ounces of litharge. Ram up the portion of the pattern extending into the match frame precisely as in hand molding, strike-off and screw the bottom board in place. Roll over the match, pattern and green sand half and *cope-off;* then draw the pattern and mend parts of the match that are broken in drawing. Let the match stand in a warm, dry place for 10 to 12 hours, when it will be ready for a thin coat of shellac.

### Aluminum Match-Plates.

Where exceptionally good castings are required from patterns having an irregular parting, an aluminum match-plate may be used to advantage. In using these plates, not only is the possibility of shift overcome, but a whole mold is squeezed at one operation.

In making an aluminum match-plate, a master pattern should be used to allow for shrinkage and finish. To make one of these plates, a mold is made in the usual way in a flask large enough to accommodate the size of the plate required. The mold should be made very carefully in order to obtain a perfect

*Presented at the Pittsburg convention of the American Foundrymen's Association.

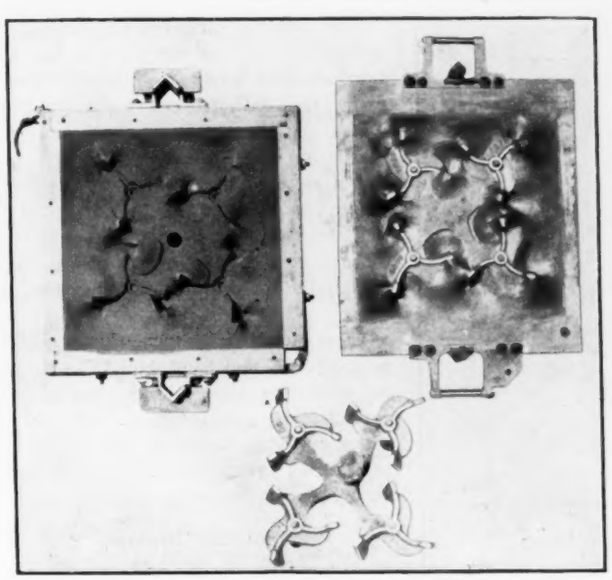


FIG. 1—IRREGULAR PARTING OF A LAWN MOWER CASTING. THIS ILLUSTRATION SHOWS THE COPE PLATE, COPE MOLD AND THE COPE SIDE OF THE CASTING

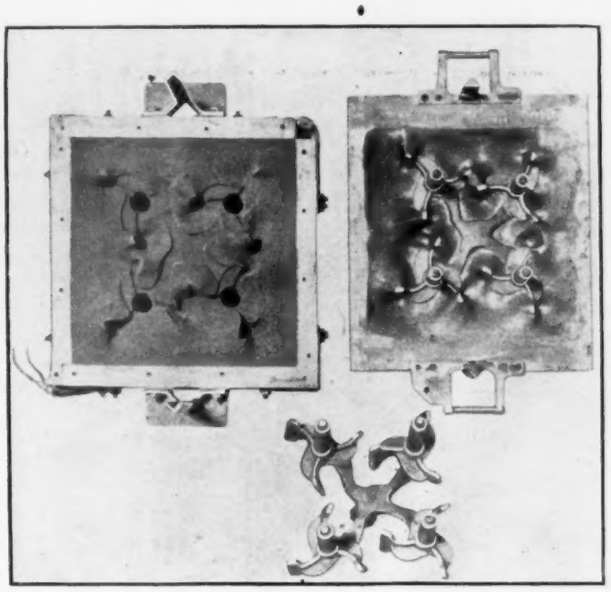


FIG. 2—DRAG PLATE, DRAG MOLD AND DRAG SIDE OF LAWN MOWER CASTING

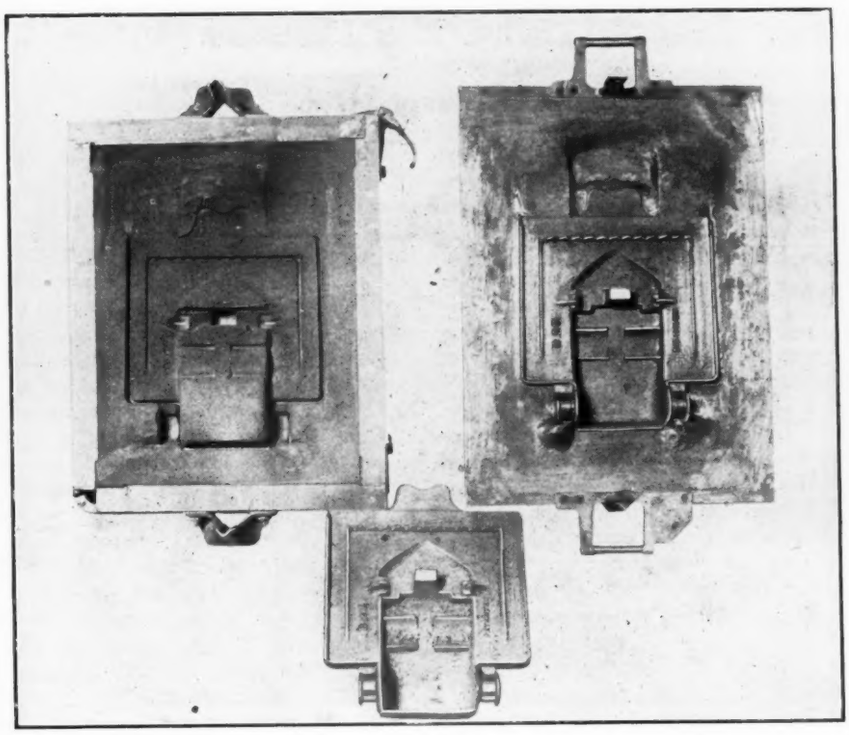


FIG. 3—JOURNAL BOX COVER MOUNTED FOR A TABOR MOLDING MACHINE, SHOWING DRAG PLATE, DRAG MOLD AND DRAG SIDE OF THE CASTING

casting, thus avoiding any unnecessary finish in the plate. When the mold is ready to close, strips of wood the thickness of the plate desired are placed on the parting of the drag, and a false parting of sand is built up to the level of the strips. The strips are then removed and the mold closed and poured in the usual manner. Care should be taken that the flask pins are in perfect condition so that there will be no shift.

After the plate casting has cooled, it should be rubbed with a fine, stiff, wire brush which usually imparts sufficient finish, but any fins or irregularities must be removed with a scraper. When the plate has thus been finished, suitable handles with guides are attached to the ends and the plate is ready for use.

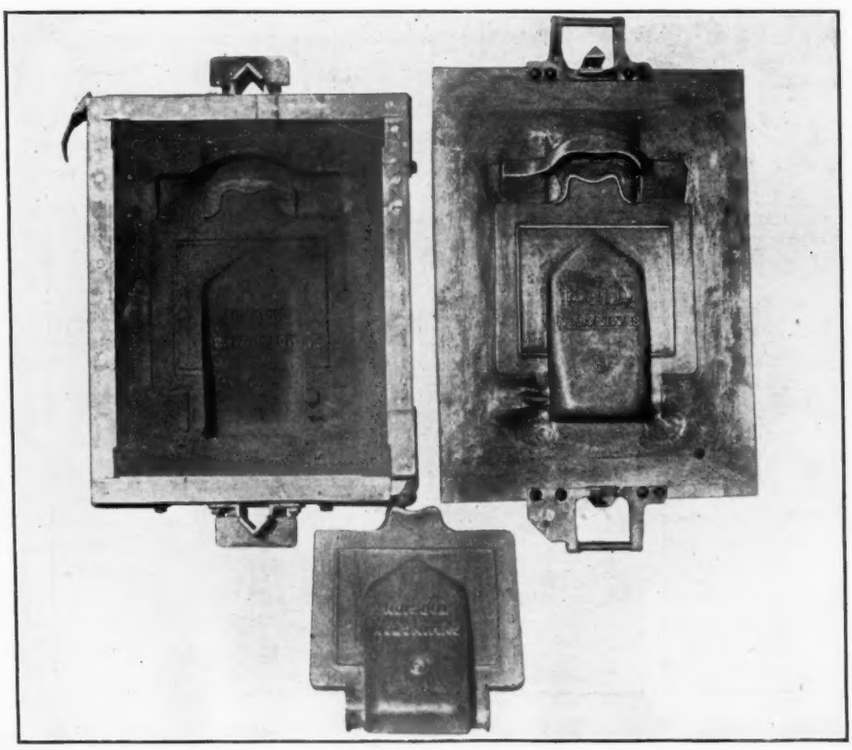


FIG. 4—JOURNAL BOX COVER, SHOWING COPE PLATE, COPE MOLD AND COPE SIDE OF CASTING

Paraffined boards are used principally for short runs of work, made from wooden patterns that are either flat-backs or split. A board made, preferably of oak, which has been boiled in paraffine for 48 hours to prevent warping from contact with damp sand is fitted into a vibrator frame and the patterns mounted on one side, if flat-backs, or on both sides, if split patterns are used. In mounting split patterns on a paraffined board, they are located by dowel pins to overcome the possibility of a shift and then the patterns may be securely fastened in place with wood screws. In the case of flat-backs, however, the patterns may be secured to the board in any way that may be convenient. With this method the whole mold is squeezed in one operation the same as with the aluminum match-plate.

### Steel Plate with Guides.

The steel plate method is used for split patterns from which castings are to be made in quantities. A steel plate, 3/16 inch thick, is made the size required and suitable handles with guides are attached to the end. The patterns are mounted one-half on each side of the plate and the whole mold squeezed at one operation, in the same manner as the aluminum match-plate and the paraffined board.

In making patterns for use in this way, corresponding halves of patterns should be clamped together and finished to have them match at the parting line, and before they are unclamped a hole should be drilled and slightly countersunk as near each end of the pattern as practicable.

The patterns are then separated and one-half is laid on the plate in the position desired and the plate is drilled, using the half pattern as a jig, after which the corresponding half pattern is placed on the other side of the plate and a piece of brass stock, of the proper length, is inserted in the drilled holes and riveted down to the countersink. These rivets should not be drawn down too tight to prevent shifting the patterns.

Sheet steel, 3/16 inch thick, such as is used for tank and boiler work, may be used for these plates, but a more satisfactory equipment is obtained by using saw disc material ground on both sides, thus saving the time consumed in straightening the ordinary sheet steel.

### Journal Brasses.

The practice of the Tabor Mfg. Co., Philadelphia, is to mount four, 3¾ x 7-inch M. C. B., journal brasses in a 14 x 16-inch flask; four, 5 x 9-inch journal brasses in a 16½ x 21-inch flask

two, 6 x 9-inch, journal brasses in a 13 x 20-inch flask, and two, 5½ x 10-inch, journal brasses in a 16 x 26-inch flask. These are molded from separate cope and drag plates. Brake shoes are handled by this concern on separate cope and drag plates, being made in this case with the aid of stripping plates, the practice being to mount two standard brake shoes in a 12 x 16-inch flask and three in a 16 x 16-inch flask. Illustrations of patterns mounted by the Tabor Mfg. Co. are shown in Figs. 1 to 6.

The Tabor Mfg. Co. has developed a special table, to be applied to jarring machines, in cases where very few molds are to be made from split patterns. One of these devices consists of six holes for flask pins so arranged that these different lengths of flasks can be used without changing the table. The table has center lines, in addition, at right angles, to facilitate the location of the pattern and smaller holes symmetrically drilled and numbered into which pins are driven close to the pattern which is prevented from shifting by driving small wedges between the pattern and the pins.

The symmetrical drilling of the holes makes it possible to properly locate the halves of the patterns for cope and drag without laying-out or measuring, by simply putting the pins in corresponding holes. A modification of this device consists in a table with the holes for flask pins and shallow slots running at right angles intersecting in the center of the table. The patterns are located by screwing metal strips to them fitting the slots. A rather special case of the application of patterns to molding machines is that required in the multiple method of molding on the Rathbone machine, now built by the Hanna Engineering Works, Chicago.

### Multiple Molding Machines.

In the multiple method of molding it is necessary to mount one portion of the split pattern on the upper head of the machine and the other portion on the lower head, as a complete mold is rammed in one flask section and when such flasks are piled one above the other, a complete mold is obtained at each joint of the stack. The only scheme of mounting these patterns is to get them accurately matched with relation to the center line through the dowel pins on the pattern plates so that when the pattern plates are attached to the vibrator frame in the ramming heads, the patterns will be in alignment.

There is no hard and fast rule for mounting the patterns on the plates, the only requirement being accuracy on the part of the patternmaker in doing the work. To mount patterns requiring an irregular parting, the same general scheme can be followed as in the making of match-plates, the only difference being that the plates must be made sufficiently thick so that they can be split or sawed apart. An interesting example of work done on this machine is the land side of a plow, the point of which is back-drafted and requires a chill. The pattern is drawn from the mold by mounting it on an inclined axis so that it will swing out.

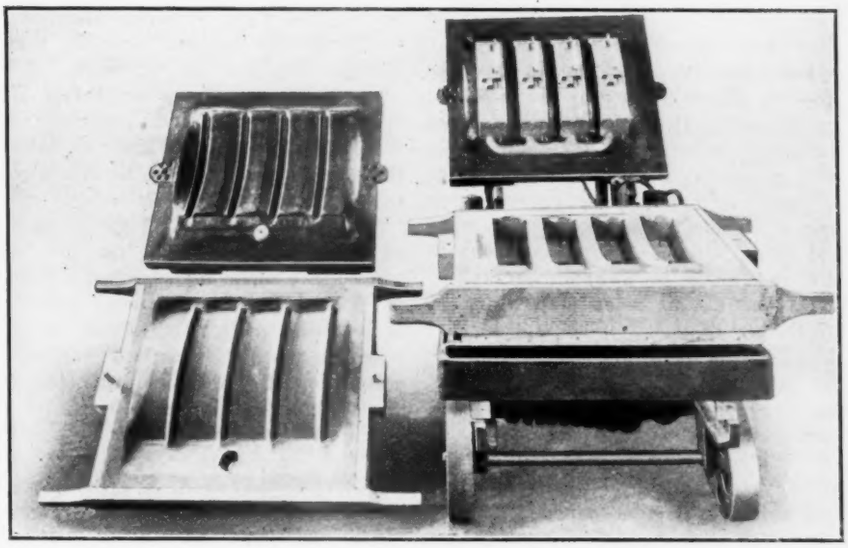


FIG. 5—BRAKE SHOES MOUNTED ON TABOR ROLL-OVER MACHINE, SHOWING PATTERNS, DRAG MATCH AND DRAG MOLD ON THE MACHINE AND COPE MATCH AND COPE MOLD AT THE LEFT

The Arcade Mfg. Co., Freeport, Ill., publishes a pamphlet entitled "Pattern Plate Making", which fully describes the making of pattern plates and gives the mixtures of the alloy used for metal plates and the composition used for composition match-plates.

The J. D. Smith Foundry Supply Co., Cleveland, handles a mixture known as the Bayer pattern composition, which resembles hard rubber in appearance and is used for making pattern plates.

Although textile machinery is now machined and assembled by modern methods in the progressive establishments, the old days of laborious hand work in fitting together pieces of such considerable size as the side frames and cross girts of looms have left their mark in the comparatively high degree of accuracy and finish demanded in the castings. The author found at the plant of the Crompton & Knowles Loom Works, Philadelphia, a very strong tendency toward attaining this end through the extensive use of molding machines and the molding machine practice is developed to a degree of efficiency and simplicity which has its lesson for the founder in any line.

Patterns for such large castings as the side frames and cross girts are made of wood, parted on a plane, when-

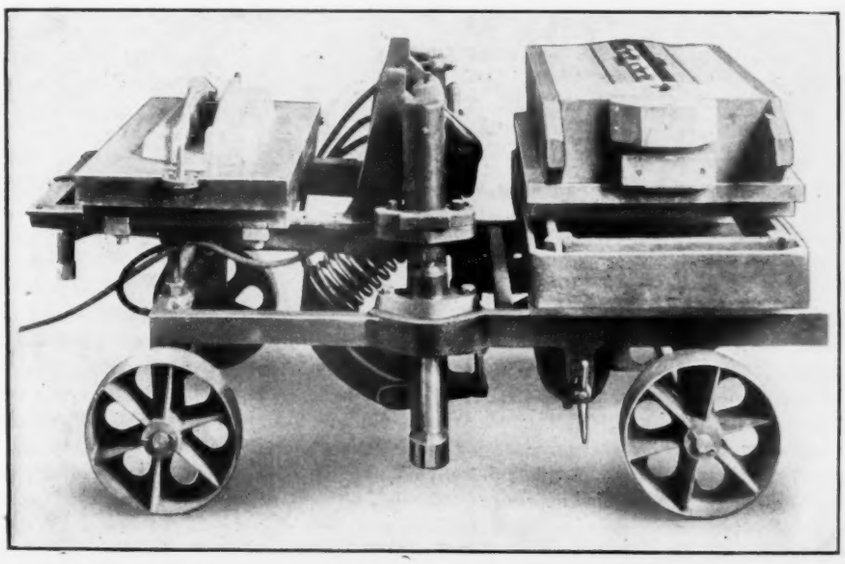


FIG. 6—DRAG EQUIPMENT FOR MOLDING GRATE BARS ON A TABOR ROLL-OVER MACHINE

ever possible, and are molded on the floor with a follow-board.

There are, in addition, a very large number of smaller parts which belong to the general run of small machine parts and patterns for these are made very generally of wood. The number of castings from any one pattern going into a complete machine is not great and as the machines are of considerable size and made in a great variety of styles, the use of wood patterns needs no further comment. The same conditions control the methods of mounting the patterns. This company has solved the latter problem by adhering to plane partings as far as it is possible to do so. Where bosses or lugs fall off the parting plane, cores are used in preference to an irregular parting.

### Pattern Boards.

The pattern boards are made of pine, thoroughly seasoned, but not as carefully selected in regard to knots or other blemishes as pattern lumber would be. These boards are found amply durable for the service required of them and are so inexpensive that mounting of a large number of patterns, which are perhaps used only occasionally, is not a serious item.

The protection which the board gives the pattern, not only in the foundry, but in the pattern storage, is an item of considerable importance. Every molder knows that one of the most prolific causes of ragged molds from split wood patterns is the back draft resulting from the breaking and wearing away of the edges of the pattern adjacent to the joint, and every patternmaker knows that these edges are first water-soaked by the molder's sponge and then broken by kicking the patterns around the sand pile. Patternmakers know, too, that no matter where rapping plates and draw plates are placed, the molder will find it necessary to drive his spike elsewhere. For these reasons the pattern board serves many useful purposes.

In storing patterns on boards it is only necessary to erect uprights, spaced according to the flask sizes and slide the boards in on edges nailed to these. The uniformity thus secured simplifies the storage question wonderfully.

### Mounting Patterns on Boards.

In mounting the patterns, an ordinary mold in an ordinary flask is rammed-up from the split, wood pattern. The mold is then separated with the corresponding half patterns left in the half molds, the drag board laid on the drag and the cope board laid on the cope and both are rolled over with the boards down.

By digging down into the sand it is easily possible to drive a couple of brads through the patterns into the boards and after removing the boards to fasten the patterns to each, where located, and the job is done. It is easily possible to mount an average pattern in this way in 20 minutes and, therefore, it is not difficult to believe the statement that it pays to mount patterns in this way for ten molds.

Not a single piece of special equipment is required to do the job and while not a single measurement is made, the job is located with perfect accuracy, because the pattern is located on the board by the mold exactly as the board must locate it in the mold later and the board is located by the flask exactly as it must later locate the flask. A mistake is impossible. There are, of course, jobs on which a plane parting cannot be secured even by the use of cores. These are handled with almost equal simplicity by making an ordinary litharge and sand match rammed against a half mold. The cope plate to go with this is made by removing the pattern from this match and ramming another match against the first. This latter will then be an exact mate of the parting surface already formed, bearing an exact duplicate of that portion of the pattern buried in the first match.

By fastening the pattern into the first match a pair of pattern plates for cope and drag is secured by a process just as simple and just as accurate as that described for plane partings. This process is thus applicable to patterns which are not split. Slender projections which would not stand well in sand can be made of wood or metal and rammed into the match.

### Hollow Frames.

Still another interesting feature is the making of hollow frames and similar shapes in which the metal is so thin that it would be almost impossible to cast them with dry sand cores on account of shrinkage cracks, arising through failure of the core to crush.

Some of these are made from metal patterns in three-part molds, but a more original and ingenious way, devised by Mr. McCleary, of the Crompton & Knowles Loom Works, consists in ramming the drag in a barred flask and then ramming-up a green sand core in a box with ears exactly like those on the cope flask.

After having rammed the cope and drawn the pattern the drag is placed on the core box, the whole rolled back with the drag in its normal position and the core box lifted off, leaving the green sand core in the mold. The mold is then closed in the ordinary way. This clever expedient for avoiding the difficulty of setting a green sand core deserves a tribute to Yankee ingenuity.

The author found in Mr. McCleary, another enthusiastic advocate of the arrangement of patternmakers' work benches with their left ends toward the windows, the foreman's position being at the end of the line. With this arrangement some little clearance should be left between the wall and the left end of the bench, but wherever space will permit, this clearance should not be occupied by the tool chest, as most of the shavings fall at the left end of the bench.

Mr. McCleary has provided a vertical tool cupboard over the right end of each bench which all the men use, storing their own tool chests elsewhere. He has also installed a small bench trimmer at the right end of each bench —a wonderful time-saver.

### Paper Mill Machinery.

The parts for paper mill machinery are unlike the parts of machine tools or engines, for instance, in that this equipment must be built special to meet the particular conditions obtaining in the plant where it is to be installed. There are, therefore, few standard parts which can be used on all machines, or parts of similar design which can be made in a range of sizes.

The completed machines are large and expensive, and a design once built is seldom duplicated in its entirety. This condition naturally leads to the extensive use of wood patterns, so made that bosses, pads and core prints can be conveniently moved to suit the varying conditions and to make right and left hand castings from the same pattern.

A typical example of the larger castings used on this class of machinery is the housings which are commonly made from wood patterns with flat backs rammed-up on a plane board. The usual machine elements, such as handles, levers, cranks, gears and bearing caps can, to some extent, be used on different machines. Patterns for these are gated in wood or metal, as the number of castings required may indicate.

At the plant of the Moore & White Co., Philadelphia, such parts as are used more or less frequently are made up either in wood or metal and those that do not have plane partings are worked with hard sand matches. Most of these gates are made with lugs for screwing onto vibrator frames. The patterns are stored in their matches and are attached to the vibrator frames as required in the foundry, one vibrator frame for each size flask only being used.

### Casting Rolls for Paper Machines.

The casting of rolls for paper machines is an interesting feature, characteristic of the manufacture of such machines. These roll castings must be absolutely sound, without surface defects, as finished castings having such defects would mar or tear the paper

The rolls are used in large numbers and a great variety of sizes. On account of the requirements noted, they are always cast on end and, wherever possible, made with a considerable extension at the cope end which acts as a riser and collects the dirt in the casting. This riser is subsequently cut off.

The smaller sizes of rolls are cast from complete wooden patterns. Where special diameters of rolls are required, these are frequently made-up by lagging the wood patterns and cutting out the sand to the lines indicated by the lagging in the mold. Medium size rolls are made by the Moore & White Co. by a very ingenious method on a Tabor power-ramming, stripping plate machine.

Four patterns, each equal in length to the depth of the flask, are mounted on the machine. The flasks are then rammed and stacked to the number required to make the desired length of roll, thus making all lengths of rolls of any one diameter from the one pattern and permitting molds of a size very much in excess of the capacity of the machine to be built-up. The cores for the rolls are built-up of hay rope and mud on an arbor.

The larger sizes of rolls are made from a short section of iron pattern which is drawn up as the construction of the mold progresses. Cores for these, as well are made from hay rope and mud. The largest sizes of rolls are made in loam.

Another interesting process, observed in the plant of the Moore & White Co., is in connection with the construction of a speed changing device, which consists of a pair of cones on which a belt is run. These cones are required in varying diameters and lengths and in varying proportion of diameters, between large and small end. This range is covered by a single set of patterns by making all the cones of the same angle and making the patterns in sections so that sections can be removed or added to either end of the pattern, thus forming the casting of a small cone from a pattern made by using the smaller sections of pattern; a cone of large diameter is made by dropping off the sections at the small end of the pattern and adding a section or sections at the large end; a long cone having a greater difference of diameter between its ends is made by adding sections at either or both ends.

Large cones are not made in a single casting, but are built-up of sections forced onto the shaft. The various proportions of cones are built-up in the same way as the cone patterns for the smaller sizes, that is, by using larger or smaller sections.

# Carbon Control in Cast Iron*

*By R. Buchanan*

BY CARBON control is meant the thermal, chemical, and mechanical means employed to control the carbon, both as regards condition and quantity. Sometimes, indeed oftenest, two of these will be acting at the same time. For instance, when the blast is blowing the coke into a state of incandescence, the oxygen of the air may be oxidizing, that is burning, some of the silicon, manganese and carbon in the iron. This is a combined thermal and chemical effect. Carbon exists in three *allotropic* forms. By allotropic is meant there are forms of carbon which chemically are the same, but which differ in appearance and structure. The three forms of carbon are charcoal, graphite and the diamond. Charcoal we shall leave out of consideration as not affecting the subject now treated, and only mention the diamond as having been produced in minute sizes from the graphite in pig iron, by Moissan in his historic experiments.

Carbon exists in gray pig iron, largely in the graphitic form, and in mottled pig iron the carbon is partly in the graphitic and visible form, and partly as combined carbon; that is, the combined carbon is present, but is invisible through being dissolved in the iron. In white pig iron the carbon is wholly dissolved in the iron, and so is invisible. This dissolved carbon, though invisible, has most potent influence, and it is hardly too much to say that the iron founder who can control the quantity and condition of the carbon required in the particular castings he has to make, has very largely solved the difficulties he has to contend with, so far as his mixtures of iron are concerned. In short, such a result will be sufficient proof of very considerable attainments, not only in iron founding, but in metallurgy.

### Carbon and Iron.

Carbon will dissolve in gray iron in all proportions up to fully 4 per cent carbon, and is then said to be *saturated*, that is, this iron will not dissolve any more carbon. This will remain dissolved if the iron be cooled quickly. With the large percentages of carbon, some of it will re-appear as graphite if the cooling be prolonged. That is, it comes out of the dissolved, or invisible form, and becomes visible as graphite. If this iron be kept at a temperature of about 1,000 degrees Cent. for a period of several hours, the amount of graphite extruded will be greater than if the iron were kept at the same temperature during a less period of time. This illustrates the importance of the time element. The time element is important when it is considered, in relation to light and heavy castings, and it is not less important as related to test bars.

In the molten iron the carbon is wholly dissolved, or, as it is termed, the carbon is in *solution*. There need be no more difficulty in understanding the dissolving of carbon in molten iron, any more than there is a difficulty about understanding the dissolving of sugar in a cup of hot tea. Hot tea will dissolve more sugar than cold tea will. Hot iron will dissolve more carbon than dull iron. Whether you have dissolved sugar in tea, or carbon in iron, if each is allowed to cool, the tea will drop some of the sugar out of solution, and you will find it at the bottom of the cup; and the iron in cooling will allow some of the carbon to come out of solution and re-appear as graphite. All the sugar will not be deposited at the bottom of the cup; some will still remain dissolved in the tea. So with the iron on cooling down, some of the carbon will be deposited as graphite, and some of the carbon will still remain dissolved in the iron. This carbon remains dissolved in the iron until, and after, the iron is solid. This carbon is then said to be in *solid solution*, that is, some of the carbon is still in a dissolved condition, although the iron is solid. Reverting for a moment to the illustration of adding sugar to tea, if a cup of tea in which some sugar has been dissolved were frozen, that part of the sugar which had not dropped to the bottom of the cup when the tea was cooled down would be in a state of *solid solution*. It may also be recalled that Carpenter and Keeling have proved that, beginning with pure iron, there is a lowering of the melting point (and also of the setting or

*Presented at the Glasgow convention of the British Foundrymen's Association.

freezing point) with every addition of carbon. It follows that cast irons with low total carbon have a higher melting point than irons with normal carbon, say 3.5 per cent to 3.75 per cent.

The percentage of carbon has an important effect on the strength of the iron. This is partly a mechanical effect, the lines of cleavage being less in number in an iron low in carbon. There is also produced in cold blast furnace practice a structure of iron which is partly independent of the carbon contents. Swedish or other cold blast iron, low in carbon, or a hematite, which necessarily is low in phosphorus, has a higher melting point than irons which have more carbon or phosphorus. When we come to melt these irons in the cupola, we necessarily increase the quantity of coke.

### Too Much Coke.

When melting is taking place there should be a balance between the quantity of air supplied and the coke burned. The theoretical quantity of coke required to melt one ton of iron is 83 pounds, this coke having carbon 93.44 per cent. Were one pound of this coke burned perfectly to carbon dioxide ($CO_2$) the air required would equal 142.8 cubic feet, weighing 10.87 pounds, or almost 11 pounds of air to burn perfectly one pound of coke. The heating of the cupola, the formation and liquefaction of the slag, and the heat lost up the cupola stack are constants which obtain whatever the iron melted may be. So, also, is the amount of air required to burn the coke perfectly, a constant, and of the most practical character. It follows, then, that in the case of irons low in carbon, or irons having a close structure, and these are used principally in tested work, it is important that the proper balance of coke and air should still obtain. If coke be added in excess with a view to making sure that the iron will melt hot, then some of the excess carbon will go into the iron. It has been already mentioned that iron is fully charged and saturated with carbon when 4.3 per cent is present. If the melted and melting iron is in contact with excessive free carbon, it is only to be expected that it will take up more carbon, being not yet fully saturated.

### Over-Blowing.

I am certain that from this cause arises much disappointment to founders. They buy expensive irons and weaken them by injudicious cupola practice. The same applies to the melting of close irons for tested work. Close irons are charged with soft blast, and excessive coke carbon is absorbed by the iron, with the result that an open grain is developed. If test bars are tried they break at low stresses, or if the castings are subjected to pressure, leaking takes place at ribs or flanges. If the iron of a casting differs materially from the iron, or irons from which it has been made, it is safe to conclude that the melting conditions have made an alteration.

So far as is possible, an effort should be made only to melt the iron, not *change* it also. It has long been recognized that one can harden iron by over-blowing. Recent experiences have shown that softening back by deficient blast and excessive coke is more common. When the castings may simply be soft, there is not much harm done, and may be an advantage, but where tests are required, either on the testing machine or by pressure, this softening back is fatal to good results. The author has seen curious results follow excessive carbonization even with common irons. In one instance the iron, when melted, had so much carbon dissolved in it, that as soon as the metal entered the mold it cooled somewhat, and not being able to keep such a large amount of carbon still dissolved, some of it came out as kish. The result was that the iron would not run to the other side of the mold. A sample of this iron told its own story of excessive coke in the cupola. So soon as the coke was reduced to a normal amount, the metal was not only hot, but fluid. In another case a close, No. 4 pig iron, with 1.4 per cent silicon, was so softened back as to present a very open, granular iron, in a section, 1⅛ inch thick. Inquiry elicited the fact that here again deficient blast and excessive coke were the causes. If one wants to soften iron the procedure is right, but speaking generally as to what is the usual requirement, we want out of the cupola the quality and characteristics of the iron we put in.

### Lowering the Carbon.

We may now consider, very shortly, what may be done to lower the percentage of carbon in the iron when it is considered desirable that that should be done. I am assuming that the melting conditions are normal, that is, that it is desired to simply melt the iron, not change it. If we desire to lessen the carbon by excessive blast, the converse of what we have been considering, then we must take account of some results which would follow. We would probably oxidize silicon, manganese and iron, as well as carbon, and the product would readily be a variable one from day to day, unless with very careful control.

The use of steel for the lowering of the carbon contents is a growing practice, but I find very varied opinions as regards its success. One founder uses gates and runners from the steel foundry, another uses punchings, another plate scrap. Some say they have no trouble from *hard-spotting*, others have given up the use of steel on that account. One has difficulty in melting the steel, and yet another melts 10 per cent of steel in a cupola with only one tuyere and obtains good results. Where the material can be readily secured, I understand that steel gates and runners are more readily melted than plate scrap. The latter has been rolled and densified, and will be less readily melted on that account. Plate scrap is better than punchings. The plate steel will lie on the top of the bed of coke until it is either melted or burnt. Punchings may drop melted and partly unmelted to the bottom of the cupola through the spaces between the lumps of coke. That this can readily happen will be apparent to anyone who has watched the change and movement in the coke bed as melting is taking place. This partially-melted steel which has dropped to the bottom of the cupola is, I believe, the cause of *hard-spotting*. Once it is at the bottom of the cupola, there is not heat enough to melt it. It can only be melted or dissolved by the *washing* effect of iron running over it. It is thus quite possible to produce spots of steel in an iron casting if the melting conditions are wrong. It is obvious that for low carbon mixtures a cupola having a receiver is best, seeing that as soon as melted, the iron flows away from contact with the coke.

### Low Coke Bed.

Next to a receiver, the cupola with a low bed of coke will give better results than with a high bed, measuring from the bottom of the cupola to the tuyeres. It should be remembered that melted metal does not become hotter by being kept in the cupola in contact with the coke. The heat and fluidity is obtained only in the melting zone. In short, the melted metal in the cupola is hotter than the coke with which it is lying in contact.

Whether one wants to alter the carbon contents of the iron being melted, or does not want to alter it, there must be a due recognition of the conditions prevailing to produce either

effect. The burning of the coke by the oxygen of the air blown in is, after all, a chemical combination of carbon and oxygen, with the result that heat is produced. Like almost all other chemical combinations, a definite quantity of oxygen combines with a definite quantity of carbon to produce complete combustion. If there is excess of carbon as compared with the oxygen blown into the cupola, then the excess carbon is present in an incandescent condition ready to be used and absorbed by the melted iron up to the saturation point of carbon in iron. On the other hand, if the supply of coke is lean, and an excess of oxygen is present, this excess of oxygen is ready to do active work, and does it. If there is no free carbon in the form of coke for the oxygen to combine with, then it will combine with the carbon contents.

### Addition of Steel to Iron.

I shall conclude by referring shortly to the function of steel in affecting the carbon contents of the iron of which it forms part when melted. The carbon in Siemen's steel will range from 0.2 to 0.4 per cent. The other elements we neglect for the present as not affecting the general result. If we mix 10 per cent of this steel to a mixture of iron containing 3.5 per cent total carbon, the result will be as follows:

TEN PER CENT OF STEEL.

| Pounds. | | Total carbon, per cent. | Carbon units. |
|---|---|---|---|
| 900 | iron | 3.5 | 31.5 |
| 100 | steel | 0.4 | 0.4 |
| 1,000 | | | 10) 31.9 |
| | | Total carbon per cent | 3.19 |

FIFTEEN PER CENT OF STEEL.

| Pounds. | | Total carbon, per cent. | Carbon units. |
|---|---|---|---|
| 850 | iron | 3.5 | 29.75 |
| 150 | steel | 0.4 | 0.60 |
| 1,000 | | | 10) 30.35 |
| | | Total carbon per cent | 3.035 |

TWENTY PER CENT OF STEEL.

| Pounds. | | Total carbon, per cent. | Carbon units. |
|---|---|---|---|
| 800 | iron | 3.5 | 28.0 |
| 200 | steel | 0.4 | 0.8 |
| 1,000 | | | 10) 28.8 |
| | | Total carbon per cent | 2.88 |

FORTY-FIVE PER CENT OF STEEL.

| Pounds. | | Total carbon, per cent. | Carbon units. |
|---|---|---|---|
| 550 | iron | 3.5 | 19.25 |
| 450 | steel | 0.4 | 1.80 |
| 1,000 | | | 10) 21.05 |
| | | Total carbon per cent | 2.105 |

These figures assume that all the steel has been melted, and that the carbon has neither been increased nor decreased. The author has been assured that the 45 per cent steel mixture has been melted and cast successfully. It is obvious that with the power gray iron has to absorb carbon up to 4.3 per cent, if such mixtures are made with the object of having low total carbon in the product, then there must be as little excess coke used in the cupola as possible, consistent with hot melting.

### Conclusions.

From the foregoing we may make the following deductions:

Iron may have the percentage of carbon lessened by having a greater proportion of blast to coke charged.

That it is possible, by having the coke in excess, to soften back and enlarge the structure or grain of an iron which was of a close grain when charged.

That in the majority of cases it is advisable simply to melt the iron, not change it in the cupola.

That many failures and disappointments ensue from changes unexpected and unknown taking place in the cupola during melting.

That it is desirable that each founder should have the means at his disposal by which he may vary the amount and pressure of blast.

## Slagging the Cupola

*By W. J. Keep*

*Question.*—In answering a question some time ago in THE FOUNDRY, you advised slagging the cupola. We do not seem to have any success in making the slag run and we are of the opinion that our cupola is not properly constructed.

*Answer.* — It is probable that the cupola tuyeres are set too low, inasmuch as cupolas constructed to use coal on the bed usually have the tuyeres higher than when coke is used. When using coke as fuel the lower edge of the tuyere openings should not be less than 12 inches from the sand bottom, if the iron is to be drawn off as rapidly as it is melted and the tuyeres should be placed higher to conform to the amount of iron that is to be held in the cupola. The slag hole should be four inches below the lower edge of the tuyere opening, and should be about two inches in diameter. The space from the sand bottom to the bottom of the slag hole will then be about six inches. It is also advisable not to have a tuyere located directly over the slag hole. The slag is chilled in front of each tuyere and if a tuyere is located directly over the slag hole, the slag will become thick and sluggish. If a small space is left between the tuyeres over the slag hole the molten slag will not be cooled as it flows toward the slag opening. The slag is composed principally of the ash from the coke, the sand from the pig iron and the daubing which has been plastered on the inside of the cupola. To make a fluid slag, charge on the coke either a good quality of limestone, oyster shells or marble chips, approximately 20 to 40 pounds for each ton of iron melted. The limestone should be broken to the size of an egg or smaller. The slag hole should be left open until the blast is on, when it can be closed with damp fire clay. After three or four charges of iron have come down, the slag hole can be opened and if the slag does not run through the hole it can be again closed until sufficient slag accumulates to cause it to run out. Care should be exercised to prevent an accumulation of slag outside of the slag hole, which should be kept open after the slag begins to run. When the tap hole is closed and the molten iron is accumulating, the flow of the slag will be heaviest. When the tap hole is opened the surface of the iron will soon lower and the slag will not again flow until it reaches the level of the slag opening. Care should be exercised to prevent the blast from blowing through the slag hole and if this occurs it is an indication that the hole is too large. In addition, mineral wool will be blown out of the opening and will collect on everything near the cupola. A shell should be allowed to form over the flowing slag or a piece of sheet iron can be hung just above the opening to prevent the blowing of the slag.

## Atherium

Atherium is the name of a new white metal of the aluminum-magnesium series, which it is claimed is easy to roll, makes sound castings, and can be soldered, forged and welded. It is also claimed that it does not tarnish nor corrode and will withstand the action of sea water. The tensile strength of this alloy is stated to be 41,798 pounds per square inch; elastic limit, 33,712 pounds per square inch; elongation in two inches, 17.5 per cent and reduction of area, 39.1 per cent. Its specific gravity ranges from 2.4 to 2.57.

A recent patent for an anti-friction metal specifies the following proportions: Zinc, 82 per cent; copper, 1.7 per cent; tin, 5.8 per cent; lead, 9.8 per cent, and antimony, 0.7 per cent.

# ART AS EXPRESSED IN CAST IRON*

## Notable examples of artistic iron castings which reflect the skill of the artist and the molder

*By W. F. Bagnall*

THIS particular branch of the foundry trade calls into being a set of workmen or a more appropriate title would be artists, who are not generally met with in ordinary foundry practice. These include designers, modelers, wood carvers, chasers and men specially trained for filing the cast iron patterns made from the master patterns. Many illustrations in connection with this branch of the foundryman's art will be found, and the usage of what is described as the "Lost Wax Process" appeared in THE FOUNDRY in February, 1911. I make no apology for using the term art in connection with a molder or foundryman. There has yet been no molding machine invented possessing brains, and these are required in a very high degree to produce most of the examples of art castings shown herewith. The writer believes, however, that as a rule, the wax process is simply employed to obtain the first impression in lead or a composition for the master pattern, which is chased and is only used to produce a cast iron pattern. A master pattern is retained so that a new pattern can be made if the cast iron pattern should break or wear out or if a new pattern is required with some slight alterations.

### Fluid Iron.

Great strength and chemical composition are not such important factors in the iron employed in the manufacture of art castings, but to cast successfully, a very fluid iron is required, possessing a fairly high silicon content. The iron must be sufficiently fluid to fill all the corners of the mold, leaving a casting true to pattern with a perfectly sharp and clear impression of all the ornamental details of the pattern. The most important factor after the pattern is made is the molder, and no rule-of-thumb man would be successful in producing the examples of artistic castings herewith illustrated. The molder for this work must possess skill of a very high degree, careful training, steady hand and nerves, pride in his work, and, above all, brains.

*Abstract of a paper presented before the Glasgow meeting of the British Foundrymen's Association.

Cast iron was known in the time of Aristotle, 350 B. C., and through the agency of the Romans the manufacture was spread into almost every part of the then known world. The employment of cast iron for domestic architecture is of a comparatively early date and in the United Kingdom it dates from about the sixteenth century. The author does not propose to give a history of cast iron, but he would like to touch upon one or two points as illustrating the growth of its manufacture, compared with the growth of art and design in castings. About 1709 a number of enterprising manufacturers tried to make iron by a system of using pit coal. In a journal issued in 1846, we find the Coalbrookdale Iron Works mentioned as being in existence since the time of Charles I. Ornamental castings were first successfully made about 1834, before which time such work was considered impossible. From an artistic point of view, internal decoration supplies us with the largest number of examples, and some of the most famous and noted names in the world of art. These, however, chiefly occur in the eighteenth and nineteenth centuries. Naturally, stove grates comprise the largest item of internal decoration on which the skill of the artist and ornamentation in cast iron can be displayed to greatest advantage. The history of the fireplace falls into two main divisions, according to the fuel burnt—the wood period and the coal period. At first there was the hearth in the middle of the room, which was followed by the introduction of the brazier; then the fireplace was removed to the wall, hooded or recessed, according as British or French custom or practice prevailed.

### Artistic Stove Grates.

Sheffield and Rotherham a generation ago led the world in the production of high class stove grates. The number of firms producing these has, however, largely decreased, and the district of Falkirk and immediate vicinity probably holds the premier position today. Though the number of firms producing these articles is much less than of yore, one or two Sheffield and Rotherham firms still produce high class artistic stoves equal to any that can be produced in any part of the world. Sheffield's pre-eminence in the production of high class artistic stoves in the nineteenth century was due largely to the designs of the great Alfred Stevens, whose ultimate triumph in the world of art culminated in the famous and well-known Wellington monument in London. Stevens was employed for years at the Green Lane works of H. E. Hoole & Co., Sheffield, and was assisted during a part of the time by the famous Godfrey Sykes.

A famous example of a cast iron mantel register, designed by Alfred Stevens, is shown in Fig. 1. The most notable feature in the scheme of decoration is the prone figure, and in the general scheme, flower and leaf ornamentation, conventionally treated, are liberally employed. The recessed back is of cast iron, richly ornamented and the plain portion of the back, which in a modern stove would be of fire brick, ends in beautifully executed rams' heads. The stove is complete with fender and ash pan to match, the design for which is quite in harmony with the rest of the work.

Fig. 2 illustrates a handsome specimen of a hall stove and must be considered the high water mark of art in this direction. The work is finely executed, full of details and yet is not too highly decorated.

Another mantel register by Stevens is shown in Fig. 3. The design for this is practically all ornament, very elaborate in execution and the only figure work consists of small heads supporting the shelf and the two masks or faces on the corner pillars. This stove is 50½ inches high, 55 inches wide over the front and the shelf is 60 x 12½ inches.

Fig. 4 is a register stove with fender, ash pan, etc., combined. The two figures which form a part of the stove are more clearly shown in Fig. 7.

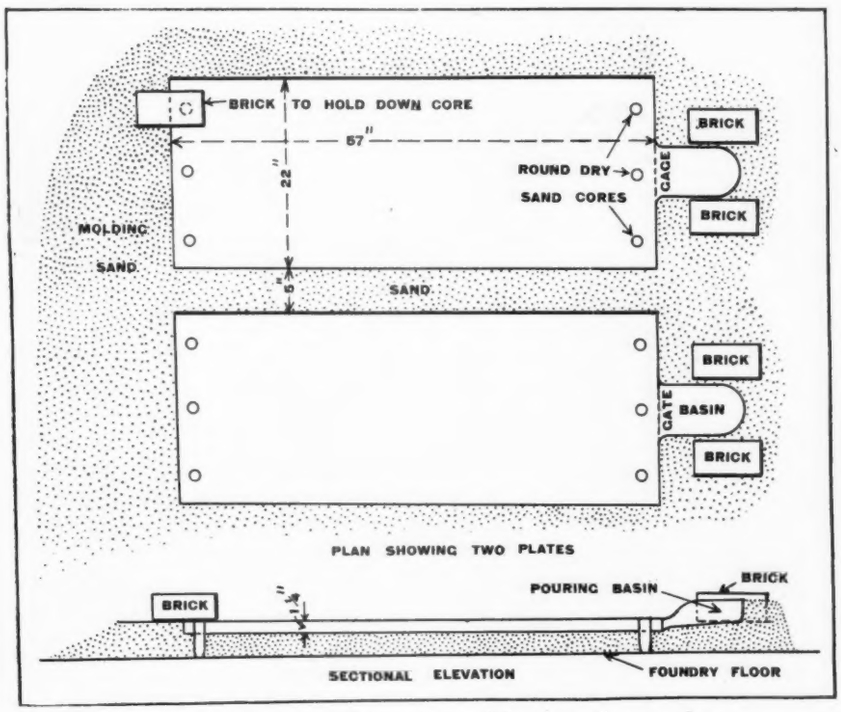
In Fig. 5 is shown a cast iron umbrella stand. The modeling of the boy is a fine specimen of art attributed to the late Godfrey Sykes, but this cannot be vouched. The patterns were purchased at a sale of a foundry now non-existent. The stand

NOTABLE EXAMPLES OF ARTISTIC CAST IRON WORK

is painted in natural colors and is exceedingly lifelike.

A group of castings for exhibition purposes is shown in Fig. 6. The most prominent feature is a fine casting in the foreground by Bell, entitled the "Eagle Slayer". The samples of garden vases call for comment, and are the finest and most artistically ornamented castings of their kind that the writer is able to exhibit. The beautiful modeling of the winged female figure forming a reading desk or lecturn, calls for admiration. Another feature is the finely sculptured figure of a child and pedestal, the panels in the base are allegorical pictures illustrating Sheffield trades and the other two, specimens of manufacture. The whole design is well executed and worthy of attention. It is the creation of a Sheffield modeler who was employed at one time by Hoole & Co. It is a credit to Sheffield work and art applied to an article not generally distinguished by any great measure of artistic treatment.

Fig. 11 illustrates a Stevens' design for a register stove, fender, etc., combined. It is chaste and elegant in design and the fine ornamentation on the metal back, of course, would




PLAN AND SECTIONAL ELEVATION OF MOLD FOR CASTING LARGE PLATES IN OPEN MOLDS

adapted in one instance to carry a vase and again designed to support a lamp post.

In Fig. 8 is shown a cast iron statue, entitled "Horse and Mare". It is the height of perfection of statuary casting and a beautiful example of the sculptor's art, adapted to patternmaking. To say that the animals are true to life is the best criticism to be given.

Fig. 9 is a sample of Stevens' work as applied to a dog grate. The chief feature of ornamentation work in this illustration lies in the back and dogs or fire rests. The dogs are a beautiful exemplification of craftsmanship, both from the point of design and as an example of the molder's art and are executed in bronze.

An illustration of a beautifully designed and decorated lamp post erected in the center of the city of Sheffield, is shown in Fig. 10. In two of be obscured by smoke and soot every time the fire was lighted. From an artistic point of view, however, the work is one of genius.

## Melting Brass in Japan

Brass in Japan is melted in coke holes in plumbago crucibles, much the same as in other countries. The zinc is imported from Europe and the supply is so limited that scrap zinc imported from China is used in the rolling mills for making the brass. The mills can manufacture rod up to 5 inches in diameter. In addition to rods, brass and copper tubes, sheet and wire are made. The tube mill is a new industry, and only one is in operation at present. It is equipped with British machinery and has been in operation since 1909.

## Casting Large Plates in Open Molds

Although the advantages of casting heavy, flat plates in open molds are quite generally appreciated by foundrymen, the open mold method, on account of obvious difficulties, is employed only in comparatively rare instances. The difficulty has been to produce smooth, true castings, free from blow-holes and to sufficiently protect the ladlemen from the intense heat radiated by the large exposed surfaces of hot metal. An interesting method of casting flat plates in open molds has been developed in the foundry of the Pawling & Harnischfeger Co., Milwaukee, which obviates the number of difficulties that have heretofore surrounded this class of work. The method has been thoroughly tried out and all sorts of large flat plates, having one plane surface, are now cast successfully in open molds in this shop.

The accompanying illustration shows a part of a mold for the side plates of large cast iron flask. These plates are 57 inches long, 22 inches wide, 1¼ inches thick and weigh 315 pounds each. Three round holes are cored through the end of each plate. The plates are cast in groups of from four to six. The general features of the mold are shown in the illustration of the two plates, and the advantages of this system are seen to be more matters of detail than of principle.

In making the molds a bed of well-riddled, comparatively dry molding sand, about 5 or 6 inches thick, is spread on the floor, the bed being large enough to contain the requisite number of plates. The bed having been *very lightly* rammed, the pattern is laid on it and worked to a true bearing in the sand, care being taken to keep it level. Sand is then rammed very lightly around the edges, the mold is struck off and the pattern is drawn.

As shown in the illustration, a gate from 6 to 8 inches wide, is made at one end of the mold, large enough to serve as a combination gate and pouring basin. The gate is flanked by bricks which help to hold the sand in place. Round, dry sand cores are used and are weighted with bricks to prevent floating.

### Ramming and Gating.

The two important features of the mold are the ramming and the gate. The ramming must be just right to

insure a successful casting and some experience is necessary to produce results. It may be stated, however, that the sand must be soft and uniformly rammed all over the mold. Hard spots will be sure to produce blow-holes in the castings. The sand must be several degrees softer than in the ordinary mold and rammed so that only a slight pressure of the finger is required to make a distinct impression. This light, careful ramming is necessary because the sand bed itself is depended on to carry off the gases and it must be loose enough to be self-venting. If the bed is properly rammed so the gases can easily escape, a clean, true casting will result. The gate must be wide and clear so the metal will pour into the mold fast and sweep rapidly to the farther end, otherwise a cold-short casting will result, since the loss of heat in the open mold is very rapid. A large gate is also necessary so the pouring can be done quickly in order to protect the ladlemen from the heat.

The mold farthest from the cupola is poured first, followed by the others in succession, finishing with the one nearest the cupola, because it is impossible, on account of the radiation, to remain close to a freshly poured, full mold any length of time. A geared crane ladle is to be preferred in pouring.

The open mold, which does away entirely with flasks and the necessity for a cope, reduces the molding labor fully 60 per cent. Molding plates in a flask requires at least 13 distinct operations on each plate, which in the open mold method is reduced to five. Four open molds for 22 x 57-inch flask plates described above are produced in two hours by one apprentice at a cost of about 30 cents for molding labor.

## Rational Analysis of Sand*

Place one gram of the sample in a 150 c. c. Griffin Jena glass beaker (sample should previously have been ground to 100 mesh and dried to 100 degrees Cent. for one hour). Moisten the sample with about 5 c. c. water, then add 15 c. c. $H_2SO_4$—1.84 specific gravity. Stir the mixture well, cover with a watch glass and digest on the hot plate for 12 hours, at a temperature high enough to make the acid fume. Remove the beaker, allow it to cool and dilute with 100 c. c. cold water. Stir thoroughly, bring to a boil and filter through a close filter (S & S No. 589 Blue Ribbon) washing well with hot water. Discard the filtrate[1] replace the paper and residue in the original beaker and digest this time with 100 c. c. of 10 per cent *NaOH* solution for 30 minutes at boiling temperature. Filter again through a close filter, washing by decantation three times with 1 per cent *NaQH* solution, leaving the bulk of the filter paper and the residue in the beaker. To this add 50 c. c. hot 1-3 *HCI*, stir thoroughly, then continue the filtration and transfer the contents of the beaker to the filter. Wash well with hot water until the washings are free from chlorides. Burn the residue *wet* in a weighed platinum crucible and ignite to constant weight. The weight obtained is the weight of the quartz plus feldspar. This weight subtracted from one gram gives the weight of *clay substance* in the sample.

Fuse this quartz plus feldspar residue with five times its weight of $Na_2CO_3$ in the platinum crucible and determine the alumina present. This is the alumina of the feldspar. Calculate the weight of the feldspar, subtract it from the weight of the quartz plus feldspar, and obtain the weight of the quartz—

Feldspar $Al_2O_3$, $K_2O$, 6 $SiO_4$ — 18.34 per cent $Al_2O_3$

Respective weights. Using these two additional results, together with the rational analysis and the formula given below, calculate the ultimate composition:

Total silica.—The per cent quartz plus 64.74 per cent feldspar plus 46.51 per cent (clay substance minus iron oxide).

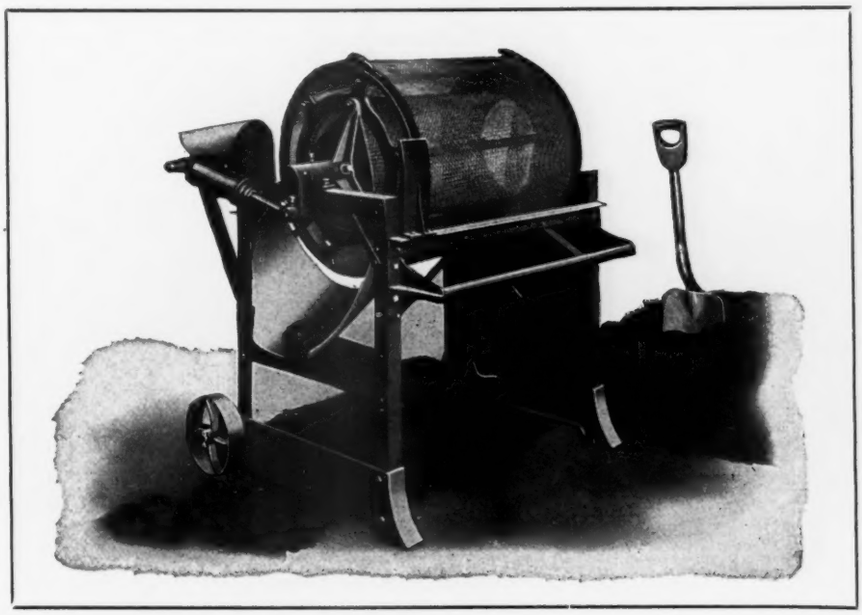
Total alumina.—The alumina of the clay substance plus the alumina of the feldspar.

Total iron oxide.—The iron oxide of the clay substance.

Total alkali.—16.9 per cent of the feldspar.

## Rotary Sand Sifter

The rotary sand sifter shown in the accompanying illustration, built by the Arcade Mfg. Co., Freeport, Ill., consists of two wire mesh cylinders, each 30 inches long, the inner cylinder being 14 inches in diameter and the outer cylinder, 24 inches in diameter. By means of a series of rollers and lugs, the cylinders are jolted four times during each revolution, thereby breaking the lumps and preventing the sand from clogging the wire mesh and the sand consequently passes through the sieve as fast as it can be shoveled into the inner cylinder. The sieve is tilted to carry off stones, iron and other foreign particles which fall into a chute and are discharged from the front of the machine. The sifter is portable, being mounted on two wheels and a handle is provided for moving the device from floor to floor. The frame is rigidly constructed of steel angles and the cylinders are operated by a compressed air motor, but they can be driven by an electric motor or the machine can be furnished with pulley for belt power.



PORTABLE, ROTARY SAND SIFTER

*Presented at the Pittsburg convention of the American Foundrymen's association.

[1]To obtain the approximate ultimate analysis of the sand, instead of discarding this filtrate containing the sulphuric acid solution of the iron and alumina of the clay substance, oxidize it with bromine, precipitate the iron and alumina with ammonia and determine their re-

# CONVENTION OF BRITISH FOUNDRYMEN

## Report of the proceedings of the annual meeting held at Glasgow and discussions of the papers read

*By J. Horton, Staff Correspondent*

FOR THE second time in its history the British Foundrymen's Association this year held its annual convention at Glasgow, Scotland, the proceedings occupying three days, commencing Aug. 8. The second visit was made under the happiest auspices and the occasion served as a useful comparison between the present day of prosperity of the organization and the small beginning of the association, when in 1905, in the second year of its existence, the foundrymen met in this city. At that time there were about 100 members enrolled, but on this occasion a total membership of 674 was reported and the Britishers are distinctly proud of the fact that their strength now exceeds that of the American Foundrymen's Association. The visit was made at the urgent invitation of the Glasgow section, which has a membership of about 200.

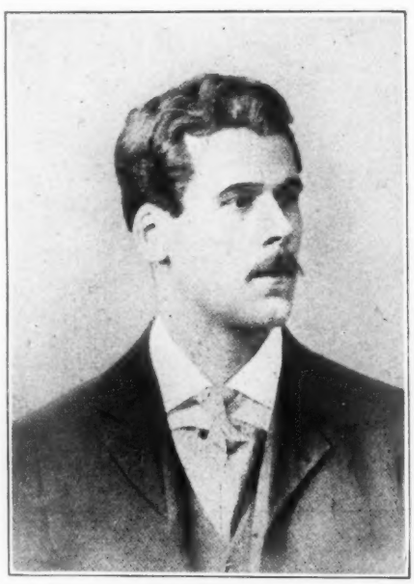
As an engineering center Glasgow has no superior in Great Britain and owing to the great activity of the manufacturing plants in this district, the local members were, for the most part, too busy to attend the professional sessions, although they mustered in great strength at the big reception held at the council house on Wednesday evening, Aug. 9.

### Opening Session.

The opening session was held on Tuesday morning and in the absence of the lord provost, Baillie Russell offered a municipal welcome to the association. Mr. Macdonald endorsed the welcome on behalf of the governors of the Technical College, who stated that the growth of the association had been coincident with that of the college, inasmuch as the first meeting of a technical body in that building was that of the British Foundrymen's Association in 1905. Baillie J. King, president of the Scottish branch of the British Foundrymen's Association, acknowledged the cordiality of the welcome and congratulated the members on having a Scotch Englishman as the head of the association in the person of Percy Longmuir. Mr. Longmuir in reply, humorously described himself as "one of the Scotchmen who had left his country for his country's good." This concluded the preliminaries and apologies were read from Prof. Turner, R. Mason, C. Finch and others, and sympathetic letters were directed to be sent to the two last named gentlemen, who were absent through illness.

### Report of the Council.

In its annual report the council of the British Foundrymen's Association recommended a prize scheme for the best papers presented at the branch meetings. It was suggested that the prize consist of a framed diploma, suitably inscribed, one to be allotted to each branch, to be awarded to the member or associate member giving the best paper at the annual meeting. The awards committee will consist of the president of each branch and the literary committee of the council of the association. The council has also in contemplation an award for the best paper of the year, this award to be applicable to the association as a whole and which will carry with it high distinction and honor to the recipient in the foundry world. During the year Geo. Hailstone, secretary of the Birmingham branch, has been awarded a Carnegie research scholarship of a value of $500 and he is now investigating liquid contraction in cast iron. T. Swinden has been awarded a further grant of $150 as a Carnegie research scholar and is continuing his work on molybdenum steels.



PERCY LONGMUIR,
PRESIDENT OF THE B. F. A.

The membership of the association was largely increased during the year, 674 now being enrolled as compared with a total of 571 at the last annual meeting. The total revenue for the year amounted to £335 8s 2d, while the expenditure was £285 9s 10d, leaving a balance of £49 18s 4d. The total balance in hand amounts to £102 8½d.

### Election of Officers.

Officers for the ensuing year were elected as follows: President, Percy Longmuir; senior vice president, C. Jones, Cardiff; junior vice president, S. A. Gimson, Leicester, and J. H. Allbut, secretary. The following council members were also elected: W. F. Bagnall, Sheffield; J. Ellis, Southampton; C. Heggie, Birmingham; S. Hailstone, Birmingham; H. Jewson, East Dereham, Norfolk; R. W. Kenyon, Accrington; H. Pemberton, Derby; M. Riddell, Glasgow, and T. Swinden, Sheffield.

### Presidential Address.

The address delivered by Percy Longmuir is in part as follows:

In the foundry world many papers are written, but very little definite study is published. The field for work is large and work, not writing only, is wanted. The expression of mere opinion, unsupported by facts or observations, is too prevalent and it is the duty of earnest students to encourage the publication only of that which carries the impress of work done, or of observations carefully made. As a technical association, we, of course, belong to the class which devotes itself to the acquirement of knowledge.

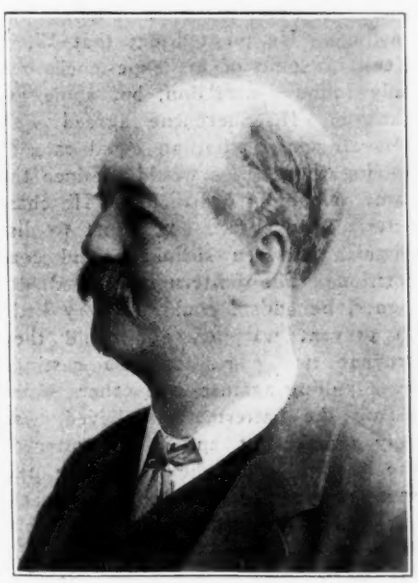
This association covers one of the least trodden fields of metallurgical activity and while much has been written, very little actual work has been accomplished. As an association of active workers we expect every member to continue his quota of solid work and to give others the benefit of his observations when pioneering work has been done. It is the duty of each member of this association to apply himself to the development of foundry thought and real foundry progress. The days of the spectator have gone, and, gentlemen, it rests with you to show that the inside man has more than a passing interest in the game. It is one that is worth playing and further is worth every possible effort,

but it must be played squarely with the sole object of promoting the advance of the art of founding metals which embraces metallurgical aspect in regard to brass, bronze, iron, steel and steel alloys and includes great possibilities connected with molding methods and materials. In another direction there is work to be done in the way of cost systems, estimating and management. The arts of management, actual cost accounting and intelligent selling, demand the application of much serious work while the metallurgical possibilities of production and after treatment are practically boundless.

### Cast Irons for Foundry Purposes.

Herbert Pilkington followed with a paper, entitled "Cast Irons for Foundry Purposes," which is given in part herewith:

This paper does not deal with soft foundry irons, but will consider the growing demand for strong pig iron suitable for cylinders, rolls and other high class work which require a close, dense and strong pig iron of a high tensile strength. To a large extent this demand has been met by the manufacturers of what might be termed *artificial* pig iron, which has been remelted and refined. The stock materials used for this purpose consist of scrap, ingot molds, rolls, etc., mixed with a pig iron to which ferromanganese or spiegeleisen may be added. These are manipulated to produce a certain supposed ideal composition of iron and a large amount of this iron is imported. The writer ventures the opinion that the iron resulting from these mixed products, many of which are burned, is in



S. A. GIMSON,
JUNIOR VICE PRESIDENT OF THE B. F. A.

no sense a satisfactory substitute for the natural pig irons which were formerly more plentiful than at present. These artificial irons are rarely, if ever, homogeneous, being composed of materials which do not readily mix into a homogeneous mass, owing to their widely differing compositions and character.

Those who use such irons and who do not employ a chemist should look closely into the carbon conditions that obtain, by the aid of a consulting chemist. The writer is of the opinion that it has again become necessary to produce iron made naturally from iron ores which will fulfill the conditions demanded by modern foundry practice and which are free

H. E. ALLBUT,
SECRETARY OF THE B. F. A.

from oxygen, homogeneous and of considerable strength. Among mechanical tests the tensile test should only be relied upon, as the transverse test is unmechanical and unreliable. There are no straight transverse bars and, in addition, they are not machined. Furthermore, the characteristics of the iron are in no way properly defined, even if the bar were mechanically accurate. These irons must be judged by the accurately machined and easily measured tensile test bar and these tests must always accompany chemical or microscopic investigation, so far as any work of research in castings or pig iron is concerned.

### Sulphur.

One of the peculiar features investigated in the sale of strong pig iron is the demand made by many foundry managers for low sulphur, which can be readily understood in the case of soft iron, but which, in a strong, tough iron, should be comparatively high. Many of the best cold blast pig irons contain 0.10 per cent sulphur and up to this amount the effect of the sulphur is to close the grain of the iron. The impression that it produces unsoundness does not hold in this class of iron, which has a tensile strength of from 32,000 to 36,000 pounds per square inch.

### Cold and Hot Blast Iron.

Soundness is, of course, of importance in such an iron in which the silicon must be low, as a rule not exceeding 1 per cent in the very strongest iron. Fluidity and soundness are secured by 0.5 or 0.6 per cent of phosphorus and at least 0.7 per cent of manganese which frequently is as high as 1 per cent. The effect of this is to produce a high combined carbon. In this connection it may be pointed out, that the assertion frequently made that the use of cold blast in making such iron has some peculiar effect upon the iron itself, is erroneous. If the silicon is of the correct percentage it makes no difference whether the iron is made with cold or hot blast. It is within the experience of all blast furnacemen at hot blast furnaces that the blast temperature, at times, must be lowered to keep down the silicon in the iron, because the furnace itself is too hot or on account of an accidental shortage of lime in the slag.

The following analyses, typical of many irons, indicate that it is possible to obtain as low silicon in hot blast iron as in cold blast iron: Cold blast iron—Silicon, 1.02 per cent; sulphur, 0.08 per cent; phosphorus, 0.4 per cent, and manganese 0.89 per cent. Hot blast iron—Silicon, 0.75 per cent; sulphur, 0.08 per cent; phosphorus, 0.60 per cent, and manganese, 0.78 per cent. These irons were made from practically similar materials. The terms hardness and softness have frequently given the writer much trouble in connection with foundry pig iron and he is in agreement with Prof. Turner's remarks on the subject which follow. "Hard cast iron is brittle, and is deficient alike in crushing, transverse and tensile strength and seldom produces smooth castings. With metal which is a little less hard, the maximum crushing strength then is obtained, while on rendering it a

C. JONES,
SENIOR VICE PRESIDENT OF THE B. F. A.

little softer or, as the workman would call it, 'moderately hard,' the maximum transverse strength is obtained. With slightly softer cast iron the highest tensile tests are obtained." There is a somewhat prevalent idea among founders that if considerable strength is required, a hard iron must be employed. Doubtless this is

true in connection with crushing and transverse tests, but certainly not for tensile tests.

It can be shown that phosphorus up to 0.75 per cent does not affect the strength of this iron, but materially improves its soundness. It is advisable to do as little mixing in the cupola as is possible and to use a pig iron directly designed for the castings required. This, of course, is an ideal way of working, which in many foundries would be impossible, but for very great strength and soundness in the castings it is undoubtedly the best way.

F. J. Cook, in opening the discussion, said that there was undoubtedly a big demand for the special pig iron referred to by Mr. Pilkington and he expressed the hope that furnace operators would make an iron that could compete with refined iron. In regard to sulphur he said that this element is frequently wrongly blamed for defects in material. One point that must be remembered is that high sulphur iron must be melted and cast very hot. In regard to silicon he advised that if it does not exceed 1.25 per cent, iron of high strength could be obtained. The carbon content he considered the most important element and he believes that the nearer it is to 3 per cent the better would be the results. If the phosphorus were limited to 1 per cent and if the silicon were within 1¼ per cent, the benefit obtained through fluidity and homogeneity would counterbalance any weakening of the metal. He also emphasized the importance of physical conditions which would produce a totally different result, even with metals of the same chemical content.

James Horne said that he usually mixes the metal in the cupola while additions are made to the molten metal in the ladle. The results from this practice have been exceedingly satisfactory. At his works from 20 to 50 tons of iron are melted daily in one cupola and by making additions in the ladle, hot blast iron can be used for special products and a considerable saving is thereby effected.

E. Adamson, Sheffield, discussed the growing practice of mixing steel with iron and he did not approve of this, as it frequently results in a lack of homogeneity. He did not agree with what was said about the value of the tensile test bar as against the transverse test bar, and as to sulphur he stated that one of the strongest irons ever made was Finspong iron, a Swedish product, the sulphur content of which averaged from 0.14 to 0.16 per cent. He agreed with what was said in regard to the soundness or unsoundness of iron which was not necessarily dependent on the sulphur content, and he was also of the opinion that hard iron did not give the highest tensile strength.

Mr. Caddick, Bradford, said he was glad Mr. Pilkington was trying to provide special irons to obviate the necessity of remelting. As to sulphur, he said the difficulties were more probably due to the sulphur from the coke than from the iron. In reply, Mr. Pilkington said that he did not regard the cupola as a mixer in any way.

### Carbon in Cast Iron.

Carbon in cast iron was the subject of a paper read by R. Buchanan, which is published elsewhere in this issue. In the discussion, J. Horne said that he doubted whether iron absorbed carbon from the coke. He was inclined to the belief that it was absorbed while in a gaseous condition, probably from carbon oxide. In the foundry with which he is connected, steel has been used with satisfactory results and in addition the cost of the product has been reduced. No trouble is experienced from the non-melting of the steel or the appearance of hard spots on the castings, while the metal is easier to machine than close-grained cast iron. Trouble, however, is frequently experienced in melting the steel, the melting point of which is so much higher than that of iron. He was of the opinion that the appearance of unmelted steel and hard spots in the casting were due to the mode of charging, particularly when the steel scrap is placed on the bed of coke and the charge of pig iron on top of this. In his foundry it is the practice to charge the pig iron on the coke, following it by the scrap with the steel on top. The coke consumption, when using steel in the mixture, is slightly increased. He did not believe that the carbon content was altered by the addition of steel, but he was of the opinion that it reduced the temperature of the freezing point so that the iron would freeze more quickly.

### Warping of Castings.

"Warping in Castings of Channel Section", was the subject of a paper presented by R. R. McGowan, which is briefly as follows:

If two square iron bars, one one-half and the other three inches in section and each 36 inches long, are cast at the same time and under the same conditions, it will be found that the smaller bar, when cool, will be shorter than the heavy bar, because its small section permits it to cool more uniformly. This variation is due to contraction and shrinkage. In the heavy casting the outer surfaces of the metal cool first, but cannot contract to the full extent on account of the resistance of the metal in the center of the casting, which is still in liquid form. A contest of forces takes place which ultimately results in the outer surfaces relinquishing some of their natural contraction, and, therefore, solidify in a state that might be considered as stretched. The metal in the center of the casting then commences to set and endeavors to contract, but is prevented by the outer stretched surfaces, and finally sets, also in a stretched condition. In a bar of light section this variation in the temperature of the casting, causing the double pulling action, does not occur, as the whole casting cools at the same rate, and, therefore, allows the lighter casting to contract to its full extent. In the case of a flat plate, the edges are the first to cool and the center cools at a later stage. For this reason it is difficult to cast a flat plate. In the case of an H-section the edges on the top and bottom of the sides cool first, while the web across the center does not cool until later, but as the part to cool last was equidistant from the parts which cooled first, the forces counteract each other, and a straight casting is the result. But in the case of a channel section of rectangular form, the forces are unbalanced, and the result is a warped casting as there is nothing in the channel section to prevent the back, which in the H-section is a web, from contracting to its full extent. Therefore, the total length of the back is less than that of the edges, with the result that from a straight pattern a warped casting is obtained. The remedy is to have the pattern bent in in an opposite direction in order that the casting may warp straight.

In the discussion of this paper, C. Heggie said that the problem involved was the time taken in cooling the castings. He pointed out that W. J. Keep in some of his experiences not only found contraction, but some expansion. H. Sherburne agreed with Mr. Heggie in that an equal rate of cooling in castings would produce the same amount of contraction. He characterized as absurd any effort to distinguish between shrinkage and contraction. The patternmaker and designer, he added, could do very little to prevent warping, nor could they prevent two edges of iron castings from pulling against each other. Cambering the pattern, he believed, was only a makeshift, and if the center of the casting could be chilled at the same rate as the outer edge, the casting would remain straight. Mr. Buchanan, Birmingham, said that he thought the warping of castings was largely due to expansion and not contraction. The two edges cooled first and he pointed out that Prof. Turner had shown that the casting at a given point in its cooling was actually longer than the pattern.

### Wednesday Morning.

The meeting Wednesday morning was well attended, and two papers,

entitled "The Crystallization of Cast Iron," by C. A. Desch, and "Metallography as an Aid to the Iron Founder," by S. G. Primrose, were read by the authors, to permit the two to be jointly discussed. In his paper on Crystallization of metal, Cecil H. Desch compared the solidification of metals to the freezing of water or the crystallization of salt. This paper, in part, follows:

Most of the information regarding the crystallization of metals has been obtained by the use of the microscope. Common salt crystallizes in cubes, and when a small cube is formed, it grows by the addition of more salt to each of its sides. The crystallization of snow flakes proceeds differently, as the particles of ice grow in the form of a star, usually with six branches. These branches extend from a common center, and as they become longer they throw out shorter branches on each side, but always maintain a symmetrical form. The result is that instead of a cube, an elaborately branched skeleton is produced. The crystallization of metals proceeds along this line, but instead of being symmetrical, the crystals are often distorted and one-sided. The crystallization starts at a number of points, and if each skeleton grew equally in all directions, the solid metal would be made up of a number of small, solid masses, all similar in form. This regularity is disturbed because the metal does not cool at all points at uniform rate. In an ordinary casting the metal next to the surface of the mold cools first, so that the first crystal centers are formed there, but they can only grow inwardly and the skeletons formed are always elongated in that direction. First, a long rod or central rib is thrown out from the cooling surface into the mass of the liquid metal, then this rod gives off side branches and these again branch, until a very complicated skeleton is formed. As the solidification proceeds the spaces between the branches of the skeleton become gradually filled up and the structure apparently disappears.

Occasionally it may happen that all the liquid metal is used before the filling-up process is complete, and then the trunk and branches of the structure appear in their original form. This happens when considerable piping occurs, and beautifully formed fir tree crystals of steel have been found in the pipes of large steel ingots, the shrinkage of the metal, while cooling, having left the crystal skeletons projecting into the shrink cavity to a distance of a foot or more. Similar crystals on a smaller scale are common in the piped heads of castings of many metals.

### Microscopic Examination of Metals.

When the structure of the metal is revealed by microscopic examination the cut surface after being polished is etched by an acid, which attacks it unequally because of the difference in composition between the parts of the metal that first solidified and those that solidified last. This latter metal dissolves away and the fir tree structure of the crystals stands out very conspicuous, the base of the trunk being in contact with the mold, while the trunk itself is directed inwardly towards the center. We find, also, that the growth of each tree is limited by that of its neighbors. When the growing branch of one skeleton meets the branch of another skeleton, it ceases to grow, and a boundary, more or less irregular, is produced. This boundary is evidently the weakest place in the mass of metal and the strength of the metal will depend largely upon the direction it takes. If the branches of neighboring skeletons interlock, the boundary has a broken form, which assists the adhesion of the crystals, but if the adjoining crystals all lie in the same direction, so that the boundaries between them are nearly straight, the metal breaks along these lines as soon as it is strained. It is for this reason that square corners are avoided in hollow castings.

### Growth of Crystals in Castings.

The crystals grow chiefly at right angles to the surfaces of castings, and where, as at a corner, two sets of crystals meet, a sharp boundary, which is almost a straight line, is formed, and the casting easily breaks along that line. If the corner is rounded instead of being sharp, there is a gradual change of direction of the crystal skeletons, and such lines of weakness are avoided. In chill castings, crystallization takes place from a greater number of centers and proceeds so rapidly that there is not sufficient time for the long skeletons to be formed; hence, the crystals in such castings are smaller, and their boundaries more irregularly arranged, than in castings that have been cooled slowly. In the case of brass containing certain impurities, such as lead, these remain liquid until everything else has solidified and form isolated masses between the crystals. The strength of the casting depends, in a large measure, on the arrangement of these masses.

### Effects of Lead and Bismuth.

Lead in brass collects in little globules, which do not materially weaken the metal if present only in small quantity, while bismuth forms thin, highly brittle films between the crystals, preventing them from adhering to one another. For this reason bismuth is a far more dangerous impurity in brass than lead. Besides such casual impurities, many alloys and most irons contain constituents which normally remain fluid after the greater part of the mass has solidified, and this part that remains liquid longest is known as the eutectic. In an iron containing 1 per cent of phosphorus, the greater part of the latter remains in the eutectic, and appears in the form of brilliantly white patches when the metal is cut. These consist chiefly of phosphide of iron lying between the crystals of iron. This phosphide is hard and brittle, and contributes to the brittleness of the iron.

### Metallography.

John S. G. Primrose presented a paper entitled "Metallography as an Aid to the Iron Founder", which is in part as follows:

One of the most useful and scientific principles applied to foundry work is the investigation of failures, and while a trained chemist is in many cases found to be of great service in this respect, he is not, as a rule, able to do more than indicate the percentage of certain elements in the metal. He is not in position to say in what way they are arranged or combined in the casting, neither can he state the treatment to which the metal has been subjected, except in rare instances. It is of great importance to determine the internal structure of cast metal, and microscopical investigation is a useful aid in determining the cause of serious irregularities. Metallography, however, has certain limitations and can never be made to replace chemical analysis, to which it is a serviceable adjunct by locating constituents which the analysis only detects.

### Preparation of the Samples.

Care must be taken in the selection and preparation of the sample for microscopical investigation, particularly in the case of the failure of a casting. The fractured part should be preserved free from dirt and rust, and sections should be cut from the metal, not only at the face, but at a short distance from the fracture, for the sake of comparison. The samples should be polished and should be as free from scratches as possible. It is best to first examine the sample with the light falling obliquely upon it, to detect the presence of any serious scratches. The examination is then continued by direct illumination. The preliminary view of the metal after what is known as the polish attack is most serviceable in the examination of cast iron. The specimen is then etched, usually with a dilute solution of nitric acid in alcohol. This is done to develop the structure or to show the different constituents more clearly, and it is especially valuable in showing the arrangement of the combined carbon in cast iron and also for locating the sulphide and phosphide combinations. Instead of etching, very fine color effects are observed on gently heating the polished specimen, when the phosphoric portions become differently tinted by oxidation.

### Cause of Trouble Shown by Micrography.

Numerous examples of the application of micrography to metal that had shown serious defects have come under the writer's notice, and indicate how easily a little experience in comparing good and bad structures gives the clue to the cause of the trouble. In one case a heavy casting failed in service, although the test bar of the metal had given quite satisfactory results. A comparison of the micrographs of samples of the casting and the test bar clearly demonstrated that the cause was due to the use of a too rich mixture of iron, since the high silicon present had been able, during the slow cooling, to eject a large proportion of the carbon as graphite. This constituent had separated out into very weak and much elongated straight, black flakes, and thus the phosphide of iron eutectic

portions had been split up into segregations, or little detached patches showing like islets throughout the mass. The structure of the test bar was quite different and it was obvious that a wrong quality of metal had been used for the casting.

**Strengthening Effect of Aluminum.**

It is not always possible to hasten the cooling of a large mass of cast iron sufficiently to prevent the silicon from softening it dangerously by precipitating the greater part of the carbon into the graphitic form, but it is often feasible to do so by chemical means, as by the addition of a small amount of aluminum powder or ferro-alloy to the ladle. The effect of such additions is to close up the grain of the metal in a remarkable way, as shown by photo-micrographs, and for this purpose about one ounce of aluminum is sufficient for 200 pounds of metal in the ladle. Two test bars were cast from a ladle of iron at the same temperature, the metal being treated with aluminum after the first bar was cast, and photo-micrographs were made of samples of the bars for comparison. The aluminum-treated bar showed a much finer grain, and it was easily possible to forecast from the micro-structure which was the stronger material, and when tested, the aluminum-treated bar showed a transverse strength of 3,800 pounds, as against 2,688 pounds for the untreated bar, while the deflection was raised from 0.12 inch to 0.16 inch, and the tensile strength was also considerably augmented. When a casting is to be machined, the iron should be low in sulphur and not too high in phosphorus. Both these elements form compounds with iron which are very hard and brittle, and having lower melting points than the metal, they collect into balls or irregular masses, which, as they solidify last, are called eutectics.

**Formation of Shot by Iron Phosphide.**

Iron phosphide is more often encountered, and separates persistently as shot and globules, which are either firmly embedded in the metal, or are apparently extruded from the surrounding mass into some gas cavity near the center of the casting. They are exceedingly hard, and readily spoil the tools while the casting is being turned in the lathe, and they may also break away under the action of the tool, leaving a cavity or pit hole which is often a serious defect. Judging from the extreme hardness of these shot, it is often assumed that they are due to chilled metal, either caused by poor pouring or a slight sputtering in the gate when not properly constructed with a well at the bottom, but the writer has found from microscopical examination of a large number of instances, that the fault is almost always due to phosphide segregations, even in gray iron mixtures. It is not necessary for the whole globule to be of highly phosphoric iron to obtain a segregate since in a number of instances, in which the globule was almost detached from the sides of the cavity, only the skin of both shot and pit showed the phosphide eutectic. It would, therefore, appear probable that when hot phosphoric metal slowly cools, aggregates of the phosphide may form films around small portions of the metal which is thus enclosed as a bubble, and although the metal inside of the bubble may be of nearly the same composition as that which surrounds it, the separating film of phosphide alters its structure considerably, even to the extent of leaving it as a hard white spot. The shrinkage of such globule being greater than that of the surrounding gray metal, it is capable of forming a cavity, the envelope of which was originally the separating film. It is hardly possible that all globules are formed in this way, as the process may be reversed, and into the already formed gas cavity, phosphide or phosphide eutectic iron may be intruded. The difficulty is most readily removed by the use of a less phosphoric mixture of irons, although by stirring the metal in the ladle before pouring a casting of heavy section, and by pouring as cool as possible, the trouble can often be remedied.

The sulphur present in the iron is rendered almost harmless by the manganese in the metal. The manganese is usually present in sufficient quantity to form sulphide of manganese, and this either rises into the slag, or, if entrapped in the metal, distributes itself fairly uniformly in little cubical or rectangular patches.

Only one globule of iron sulphide has come under the writer's notice and its structure was quite different from the phosphide formation. Most of the blow-holes met with in defective castings are due to some defect in molding either from imperfect venting, or the incomplete drying of molds and cores, which generate steam. It is not usually necessary to use the microscope to determine the cause of blow-holes, but the extreme value of metallographic examination of defective castings should be more widely appreciated.

**Discussion of Metallography and Crystallization.**

R. Buchanan said that he understood that for electrical purposes 2 per cent of aluminum is added to cast iron to increase the electrical resistance. He was certain that blow-holes and globules in castings were the result of two different actions. He believed that the globule was extruded into the cavity and that it moved along the line of least resistance into the blow-hole. In regard to shot in castings, W. Mayer believed that these could be traced to the pouring of the metal from the ladle. Occasionally the iron is poured carelessly, causing it to splash and in addition damp sand in the bottom of the mold may cause this trouble. J. Horne believed that the existence of shot in castings was due entirely to the condition of the mold and the temperature of the metal when the casting is poured. In regard to sulphur he agreed with various speakers and said that he had worked with steel mixtures and frequently had sulphur as high as 0.14 to 0.16 per cent. This high percentage of sulphur did not harden the castings to any extent and, furthermore, no trouble was experienced from blow-holes.

H. Jewson said that he had experienced considerable trouble with shot in castings and he found hard spots in castings which destroyed all of the drills in the machine shop. This difficulty was experienced when using almost pure Scotch iron, but when the percentage of scrap in the mixture was increased the hard spots in the castings disappeared entirely.

In regard to the effect of aluminum on cast iron, J. S. G. Primrose said that it is similar to that of silicon, and when used in small quantities it appears to hasten the rate of cooling. In regard to phosphorus he said that it should be remembered that this element is in iron, not in the form of phosphorus but as phosphide. The melting point of phosphorus is lower than cast iron and it will melt more rapidly than the iron and will remain separated from it unless the metal is vigorously stirred.

**Heat Treatment of Steel Castings.**

The following paper on "The Heat Treatment of Steel Castings" was presented by Prof. A. Campion, of the Glasgow and West Scotland Technical college:

The writer has so frequently been asked by steel founders and others interested in castings of steel, such questions as "What is the best temperature to anneal steel castings?", "What is the best form of furnace?", etc., that he considers no apology is needed for bringing forward, at the present time, a few notes on the points which have to be taken into account in coming to a decision as to the treatment necessary to obtain the desired results. At the outset it must be emphatically stated that to such as quoted, it is impossible to give a direct answer applicable to all cases. There is no best temperature, no one furnace, which can be universally used; these and many other factors, some of which are herewith enumerated, that depend upon local conditions, and in order to answer such questions, one must know the local conditions and requirements. It is also to be noted that the temperature to which the material is heated, although important, is not the only factor which determines the final properties of the metal.

**Points to be Considered.**

Among the more important points which have to be considered in deter-

mining the treatment necessary to obtain the best results in the final casting are the following:

1.—The composition of the metal.
2.—The mass of the casting.
3.—The shape of the casting.
4.—The casting temperature.
5.—The rate of cooling in the mold.
6.—The rate at which the material is heated in the annealing process.
7.—The length of time maintained at the annealing temperature.
8.—The rate of cooling from the annealing temperature.
9.—The purpose for which the casting is required.

There are other factors, but the above list will suffice to emphasize the complexity of the subject and the difficulty of giving direct general answers to such inquiries as quoted earlier.

### Annealing Rolled and Cast Steel.

It may be as well, at this juncture, to point very distinctly to the great difference between the conditions necessary for successfully annealing cast material, and material which has been mechanically worked by forging or rolling. The general effect of the treatment is very similar in both classes of material, but in the case of the casting is much more marked, as the material is then in its most brittle and unreliable condition. The object of annealing steel is to toughen it and increase its reliability, not only by removing internal stresses which have been set up during manufacture, but also by causing the material to undergo a molecular re-arrangement and re-crystallization, and thus increasing its ductility as shown by the percentages of contraction of area at fracture and of elongation, and also, as a rule, a decrease in the maximum stress which is shown in an ordinary tensile test.

In the case of rolled or forged material this molecular re-arrangement and increased cohesion between the crystals is brought about as the result of the mechanical work. In the case of cast steel it is necessary to produce by heat treatment alone the changes that are brought about by work plus heat in the case of rolled or forged material.

The treatment most suitable to obtain the toughest and strongest material is not the same for all steels, that is to say, it varies considerably with the composition, and not only with the composition, but also the constitution of the material. The influence of carbon on steel is universally appreciated, and it is unnecessary to enter into that subject on the present occasion beyond mentioning that the higher the carbon the greater the internal stresses which are likely to be set up during cooling, and consequently the greater the tendency of the casting to fracture during cooling or re-heating.

### Effect of Constituents on Heat Treatment.

Constituents other than carbon, however, have an effect upon the treatment, or perhaps it would be more correct to say that the effect of the teatment upon the steel is influenced by the presence of certain constituents. For instance, sulphur or sulphides and phosphides, although present in the unannealed casting in a condition prejudicial to the strength and ductility of the material, may as the result of the heat treatment so change their form or condition as to become comparatively harmless. Sulphides are a notable example of such change. Unfortunately, this desirable change in the form of sulphides does not always take place; some material persistently resists any change in its sulphide constituents by heat treatment and remains brittle and useless. This is a point requiring further investigation. The mass and shape of the casting influence very considerably the rate of heating as if too rapid the outside of a large piece would be hot while the center might be quite cold, and the tendency to fracture would be great. The shape of the casting also requires consideration. The object should be to obtain as nearly as possible every portion of the casting heated at the same rate, and to the same temperature for the same length of time. This brings one to the time element. The changes of structure and constitution taking place during annealing are not instantaneous, but take a certain period of time, which varies with the nature of the material, shape, mass and previous treatment; and unless the temperature is maintained for the necessary time the changes are not complete, and little or no improvement of the casting may result.

### Cooling.

The cooling must be as slow as possible until all chance of chilling or change is passed, and even then the removal from the furnace must be carried out cautiously in order to prevent chilling or unequal cooling and setting up of internal stresses which would tend to reduce the strength and reliability of the material. It must be remembered that the ultimate object of the founder is to turn out a casting as tough, strong and reliable as possible, in fact to approach as nearly as possible the strength and reliability of forged steel in shapes so intricate that the cost of forging would be prohibitive.

"Art Expressed in Castings" was the concluding paper presented which was illustrated by a collection of 80 stereopticon views representing the best productions of artistic foundry work. This paper is published elsewhere in this issue.

An interesting feature of this session was the presentation to Fred J. Cook, of Birmingham, ex-president of the British Foundrymen's Association, of an illuminated address, handsomely executed and enclosed in a large frame.

### Visits to Plants.

On Tuesday afternoon, the works of G. & J. Weir, Ltd., at Cathcart, were visited. The iron foundry is a steel structure, 290 x 210 feet, and is equipped with two cupolas. The three main bays are served by four electric cranes and the central molding floor by six hydraulic cranes for closing molds, etc. The brass foundry is equipped with 17 crucible furnaces and two reverberatory furnaces and is provided with a sand-blasting plant for cleaning castings. Both foundries are equipped with large mold drying ovens. Molding machines of both English and American make are used on small duplicate work, most of the machines being of the stripping plate type. A striking feature of the foundry buildings is their high roofs, affording excellent ventilation and an abundance of light. The two foundries give employment to approximately 425 men.

On Wednesday afternoon, the members of the British Foundrymen's Association visited the Hyde Park works of the North British Locomotive Co., at Springburn. These works form only a section of the company's establishment which consist, in addition to an administration building in Springburn, of the Hyde Park works, formerly Neilson Reid & Co. and the Atlas works, both situated in Springburn and the Queen's Park works, located in Polmadie. The combined output of these plants is over 20,000 engines and 700 locomotives per annum.

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E. F. Millett, formerly general manager of the E. Stebbins Mfg. Co., Springfield, Mass., has resigned and is now associated with his brother in the Millett Brass Co., Springfield, Mass. J. Bisscher succeeds Mr. Millett as general manager of the E. Stebbins Mfg. Co.

# THE FOUNDRY

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**Accident Prevention in Foundries**

In practically all manufacturing establishments, safety devices are now being adopted with a view of reducing the number of accidents among operatives and to prevent them entirely, if possible. The large corporations have given this subject careful consideration, and in a number of instances special boards have been organized, empowered with full authority to not only recommend, but to install safeguards for machinery. In rolling mills, where the percentage of accidents has been unusually high, gears are now protected with adequate guards and in several instances the passages over rolling mills have been removed and underground tunnels substituted. The employes, in addition, are instructed in ways and means of not only safeguarding themselves, but their fellow workmen as well, and the dangerous features of their work are pointed out not only by the foremen, but by signs which are constant reminders of the dangers of carelessness. Builders of machine tools are heartily co-operating in this work and are entirely enclosing gears, which in many instances has necessitated entirely redesigning machine shop equipment. In foundries, the majority of accidents result from the careless handling of molten metal, although the falling of castings and heavy flasks result in many personal injuries. The International Harvester Co., through its advisory board, has issued a booklet entitled "Protection Against Injury, Rules and Instruction for Employes", which relate to all departments of this company's plants, and special attention is given to the style of shoes that should be worn in the foundry. The wearing of lace or low shoes by any workman employed in carrying hot metal is prohibited, and the type of shoe recommended is one that readily sheds drops of hot metal. The shoe should be of the "Congress" type, provided with rubber gores fitting close to the leg. The shoe should have as few seams as possible, a one piece upper being preferred, and the sole should be trimmed as close as possible to prevent the metal from lodging between the sole and the upper. Trousers for the molders should be made of hard cloth and should cover the shoe top. At all times they should be kept so repaired that they will readily shed the iron. The committee on the prevention of accidents of the American Foundrymen's Association reported that a firm employing about 500 workmen stated that the majority of accidents in its foundry involved burned feet and legs. To reduce the number of these accidents, this company purchased a stock of serviceable shoes and compelled the molders to wear them during the time that the heat is being taken off. In a recent issue of *The Review*, published by the National Founders' Association, the duty of the foundry foreman is outlined as follows:

> The foreman should see to it that every possible precaution is taken for the prevention of accidents, not only from the careless handling of molten metal, but from other sources as well, and he should insist that molders in the shop under his charge exercise proper precaution. When he notes that one of his molders is not properly protected, the attention of this molder should be directed to his shortcomings in the same manner as his attention would be directed to a bad casting or a poor method of handling his work. He should be told that he is taking hazardous chances of an accident and the manner in which he may protect himself should be pointed out.

Openings in floors are a frequent source of accidents in foundries and molding and ladle pits should be carefully covered when not in use. In a large eastern foundry, the ladle pit in front of the cupola is equipped with an elevator, the platform of which is raised to the floor level when the pit is not in use or when the molders are filling hand ladles direct from the spout. All overhead trolley tracks should be provided with safety switches to prevent ladles from falling off when turning from the main tracks. To prevent castings from falling from industrial cars, the sides should be guarded and the piling of castings above the height of the sides should be prohibited. Rope slings, in many foundries, are preferred to chains and in one large shop, where hemp rope is used entirely, no accidents have occurred since its substitution for chains.

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**Trade Outlook**

Foundry trade conditions in August showed a slight improvement over July and the increased activity noted in the steel trade foreshadows further improvement in the foundry business. Car orders have been more numerous than for some months and both malleable and steel casting foundries report the receipt of increased tonnage from car building plants. The jobbing trade, however, shows little change and prices throughout the country are exceedingly low. The government crop report has been a disturbing factor which may, to some extent, retard trade improvement. Notwithstanding the curtailed buying on the part of railroads, blast furnaces and steel plants are operating at increased capacity, and it is estimated that approximately 70 per cent of the steel works capacity of the country is now engaged. Pig iron values remain practically unchanged, No. 2 foundry being quoted as follows in the leading centers: Pittsburgh, $14.40; local, Chicago, $14.50; Cleveland, $14; Philadelphia.

$14.50, and southern Birmingham, $10.50. Lake Superior charcoal is unchanged at $17, Chicago. Brass foundries are busily engaged filling contracts for automobile manufacturers, who are now manufacturing cars for delivery in 1912. Nonferrous metal prices, however, have shown little change, lake copper being quoted at 12.75 cents to 12.87½ cents, and electrolytic at 12.62½ cents to 12.75 cents, New York. Lead is held at 4.57½ cents to 4.60 cents, and spelter is quoted at 6.10 cents, New York. Antimony, New York delivery, is held as follows: Cookson's, 8.50 cents; Hallett's, 7.75 cents, and Hungarian, 7.20 cents.

## Personal

P. McGrath, formerly superintendent of the Peck Bros. Co., New Haven, Conn., has been appointed superintendent of the E. Stebbins Mfg. Co., Springfield, Mass.

W. E. Baird, who has had a wide experience in the sale of core oils and core compounds, will become associated in the capacity of salesman with the Robeson Process Co., Au Sable Forks, N. Y., beginning Sept. 1.

James W. Fagans has been appointed general sales manager of Abendroth Bros., Port Chester, N. Y. Prior to his present connection, Mr. Fagans was affiliated with the Detroit Stove Works, Detroit, for a period of 13 years.

Algernon L. Curtis, consulting engineer, late of Johannesburg, South Africa, has recently associated himself with the Frodair Iron & Steel Co., Ltd., London, Eng., and represents this company in Manchester and the immediate vicinity.

E. J. Sherwin, formerly superintendent of the Blake & Knowles Steam Pump Works of the International Steam Pump Works, Cambridge, Mass., has been appointed superintendent of the Fore River Shipbuilding Co., Quincy, Mass., to succeed Leo Chappell.

P. G. Smith, secretary of the J. D. Smith Foundry Supply Co., Cleveland, has taken charge of the eastern office of this concern, located at 378 Ellicott Square building, Buffalo, from which point all eastern and Canadian business of the firm will be handled.

W. J. Cunningham has been appointed foreman of the Florence Co., Florence, Mass., to succeed J. H. Cunningham, who died recently. W. J. Cunningham was formerly with the Norwood Engineering Co., Florence, Mass., and for several years was assistant to R. P. Cunningham, superintendent of the Dean Steam Pump Co., Holyoke, Mass.

## Book Reviews

**Industrial Plants, Their Arrangement and Construction;** by Charles Day, 294 5 x 7¼-inch pages; illustrated; supplied by THE FOUNDRY for $3.00, net.

Efficiency and economy in manufacturing must be considered much more than the mere operation of the plant in which the processes of production are carried on. The factors considered by Mr. Day are largely primary. They concern the organic constitution of the factory, and hence are even of more potential importance than systems of management, which concern functional conditions. An organic inefficiency embodied in the design and structure of the plant itself is incurable, and is imposed upon all later operations.

Mr. Day's development of the subject is thoroughly adequate to its importance. He defines the principles and the practical precepts of scientific plant construction. His work has been developed by a true evolution, following scientific lines of progress, and combines the interest of scientific pioneering with the certainty and authority of conclusion that characterize the master of a specialty.

**The Life and Life Work of Chas. B. Dudley;** 269 6¼ x 9½-inch pages; published by the American Society for Testing Materials, and can be procured from Secretary Edgar Marburg, University of Pennsylvania, Philadelphia, at the price of $2.50 in cloth and $3 in half-leather binding.

This memorial volume is commemorative of the life and life work of Chas. Benjamin Dudley, Ph.D., late president of the International Association for Testing Materials, and the American Society for Testing Materials. The biographical sketch contained in this work is contributed by Edgar Marburg and "Some Glimpses of Dr. Dudley as He Appeared to His Fellow-Workers at Altoona," is contributed by M. E. McDonnell. The tributes delivered at the memorial session in honor of the memory of Dr. Dudley, at the 1910 meeting of the American Society for Testing Materials, are included, as well as extracts from editorials published in the technical press at the time of Dr. Dudley's death. The presidential addresses delivered before the American Society for Testing Materials, by Dr. Dudley, are also published in this volume, as well as a number of other notable addresses delivered before other organizations.

**Electroplating.**—By Henry C. Reetz; 5 x 6¼ inches, 99 pages, illustrated; published by the Popular Mechanics Co., and supplied by THE FOUNDRY, Cleveland, for 25 cents.

This little book treats of the electrodeposition of metals in a style so clear and easy to understand, that the beginner will find no difficulty in absorbing a working knowledge of this most interesting art. The first chapter describes how a simple electro-plating outfit may be made, and is followed by a chapter on electrical equipment, in which a dynamo and different types of primary batteries are illustrated and their uses explained. A chapter on shop equipment treats of the tanks, scrubbing troughs, polishing lathes, brushes, wheels, and dipping baskets used, and contains several full page illustrations, which give a clear idea not only of their appearance, but also the manner in which the work in handled. The chapter on cleaning goods before plating, contains formulas for the removal of grease, rust, verdigris, etc., from the object to be plated. This is followed by chapters on copper-plating, nickel-plating and silver and gold-plating, which are accompanied by illustrations of the various types of anodes in use, and also contains formulas for the preparation of the different electroplating solutions. A chapter on first aid to the injured is included. It is an instructive and practical little work and can be recommended to those who are interested in this line of work.

**Annual Statistical Report for 1910;** issued by the American Iron and Steel Association, Philadelphia; 120 pages; furnished by THE FOUNDRY, postpaid, for $5.

The annual statistical report of the American Iron and Steel Association for 1910 contains the statistics of the production of iron and steel in the United States for that year and preceding years and tables are given which show in detail American imports and exports of iron and steel, tinplate, iron ore, coal, etc. Full details are given of the shipments of iron ore from the Lake Superior and other mines, the imports of Cuban and other iron ore, prices of Lake Superior iron ore, shipments and prices of Connellsville coke, imports and exports of coal and coke, tonnage of vessels built in 1909 and 1910, etc. The price tables, which have been made more comprehensive than heretofore, will especially commend themselves to all who are connected with the iron trade. The usual tables showing the production of pig iron by grades are given in full. Canadian coal, iron ore and pig iron statistics are complete, and detailed European statistics of coal, iron ore and iron and steel industries are included.

# FOUNDRY and PATTERN SHOP EQUIPMENT

## Stripping plate machines---Sectional steel bin---Jar-ramming core machine --- Rock-over machine with stripping plate attachment

A WIDE variety of castings is required by the S. Freeman & Sons Mfg. Co., Racine, Wis., as fittings for horizontal, vertical and marine boilers and for the extensive line of agricultural implements which this company manufactures. A large foundry is operated to meet the casting requirements of the plant, and to facilitate production and to effect operating economies, molding machines are used throughout the shop. This labor-saving equipment was developed by J. W. Dearsley, superintendent of the molding machine department. The machines all embody one principle of operation, although adapted for and applied to a wide variety of patterns. As a result of the success attained in operating these machines on its own line of work, the S. Freeman & Sons Mfg. Co. is now building molding machines to meet the requirements of the foundry trade.

FIG. 1—STANDARD TYPES OF DEARSLEY STRIPPING PLATE MOLDING MACHINES

The machines are all of the stripping plate type with a circular main frame or pedestal, which is accurately machined and also serves as the cylinder in which the piston operates that raises and lowers the pattern through the stripping plate. This construction, with a few modifications, permits of the mounting of a wide variety of patterns. It has been found more economical to adapt the machine to the pattern than the pattern to the machine, and while the types shown in the accompanying illustrations vary widely in form, the same principles of construction and operation are retained throughout. All of the machines are equipped with steel band springs which counterbalance the pattern and which facilitate raising the pattern after it has been lowered away from the mold. This spring is adjustable for patterns of varying weights and practically relieves the operating lever of all strain. Patterns weighing several hundred pounds can be raised and lowered with practically no exertion on the part of the operator. The adjustment of the pattern is easily accomplished and after being set is locked in position. The piston is equipped with four manganese bronze guides which are adjustable for wear. All operating parts are enclosed and the piston and cylinders are so protected that it is impossible for sand to work into these parts.

Two stripping plate machines of standard type are illustrated in Fig. 1. The machine at the left is equipped with a pattern for molding a compound gear and the stand is used for molding the cope half of the mold. The next machine is equipped with a cone gear pattern, and forms the drag half of the mold, and the cope stand with a flask in position is shown at the right. The band spring which counterbalances the pattern is shown at the back of each machine.

A special machine, designed for a long draw, is illustrated in Fig. 2. The pattern, in molding position on the machine, forms the cheek of the mold for a double-shrouded fluted roll for a feed cutter and is 15 inches long. A casting, just after shaking-out is shown near the base of the machine, while on the opposite side, at the left, is illustrated the plate which serves to produce both cope and drag. When making the drag parts of these molds, the roll pattern is lowered through the table of the machine and the plate is adjusted by pins on the table. The lead gate, which likewise is attached to the plate by pins, is removed and the drag part of the mold is rammed. When making the cope, the only change necessary is the adjustment of the lead gate. In this way,

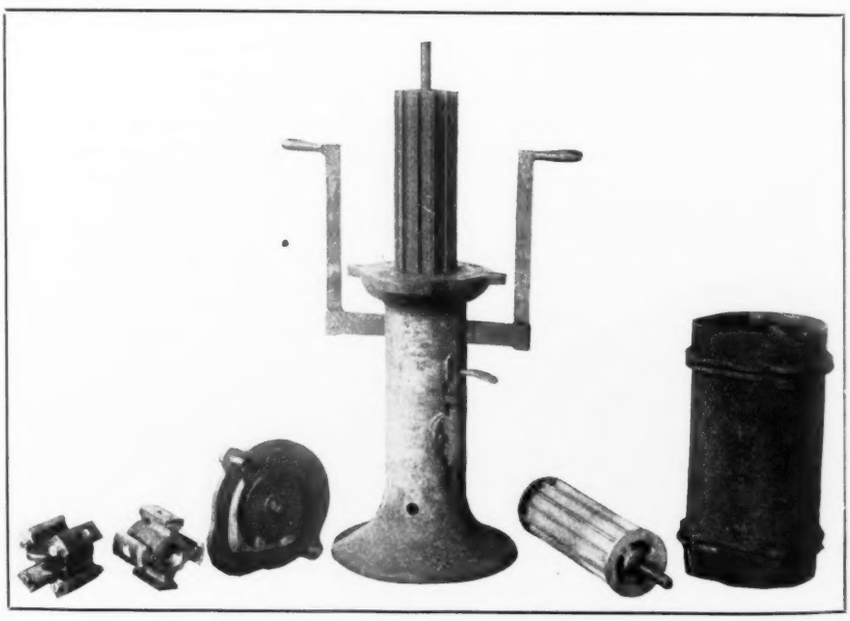


FIG. 2—STRIPPING PLATE MACHINE FOR 15-INCH DRAW, ON WHICH COPE, CHEEK AND DRAG ARE MOLDED

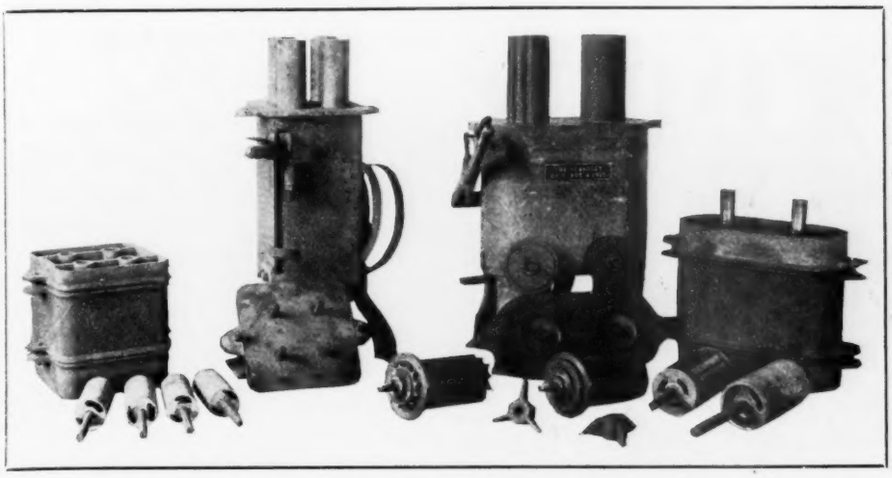


FIG. 3—SQUARE AND OVAL FRAME STRIPPING PLATE MACHINES, ON WHICH COPE, CHEEK AND DRAG ARE MOLDED

These machines are built to meet the requirements of the patterns, retaining, however, the principle of the central cylinder and piston for raising and lowering the pattern. Essentially, the capacity of the standard machine has been quadrupled and doubled, respectively, by variations in the main frames of the machines, Fig. 3. The feed cutters molded on these machines are made in three-part flasks and each machine serves for making cheek, drag and cope. One plate is used for drag and cope on each machine, a loose gate being utilized as previously described and shown in Fig. 2.

A large machine, on which the cope half of an automobile crank case mold is made, is illustrated in Fig. 4. The drag is made on the dummy shown in

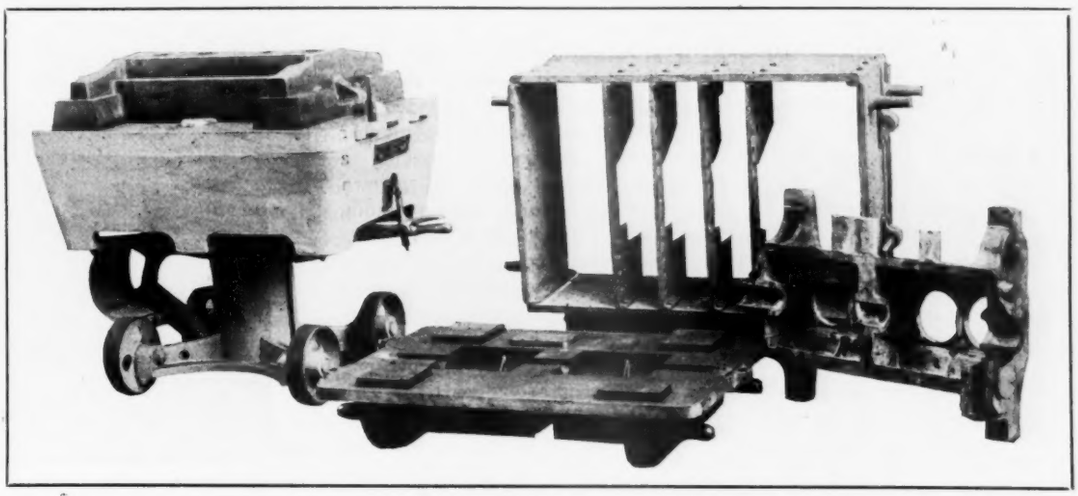


FIG. 4—LARGE MACHINE FOR MOLDING COPE HALF OF CRANK CASE MOLD. THE DUMMY, ON WHICH THE DRAG IS RAMMED, IS SHOWN IN THE FOREGROUND

one machine is used for molding drag, cheek and cope. This machine is only 24 inches high and is only a trifle larger than the flask used for this mold. The face at either end of the casting is chilled and, in addition, the steel shaft is cast in position. The flask is of special design, machined at all partings. To locate and hold the shaft in the center of the mold, bars are provided in both the cope and drag with openings for the shaft. This casting requires no machining, this work being eliminated by the special devices used in the foundry.

At the extreme left of Fig. 2 are illustrated two molding machine pistons in different positions. The center is of cast iron, being tapered to form a seat for the manganese bronze shoes or guides which can be adjusted for wear. The machine is constructed throughout with bronze contacting with iron in all operating parts.

Two machines with square and oval main frames are illustrated in Fig. 3.

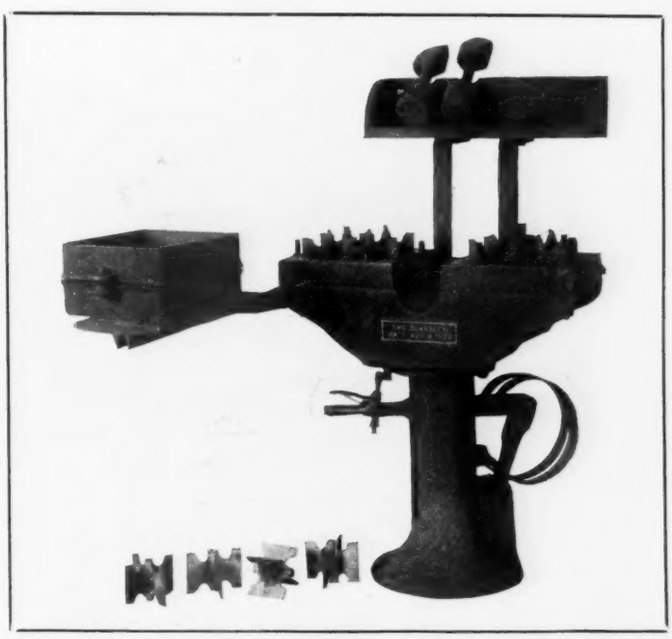


FIG. 5—STRIPPING PLATE MACHINE ARRANGED FOR BENCH AND GATED WORK

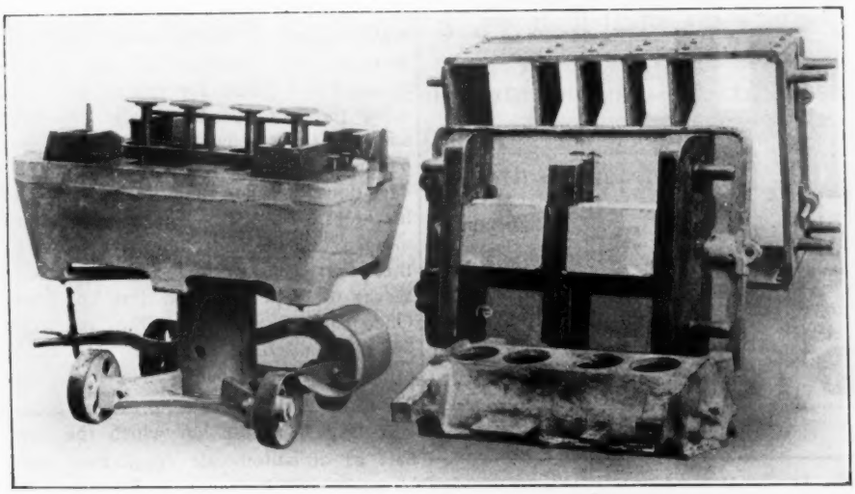
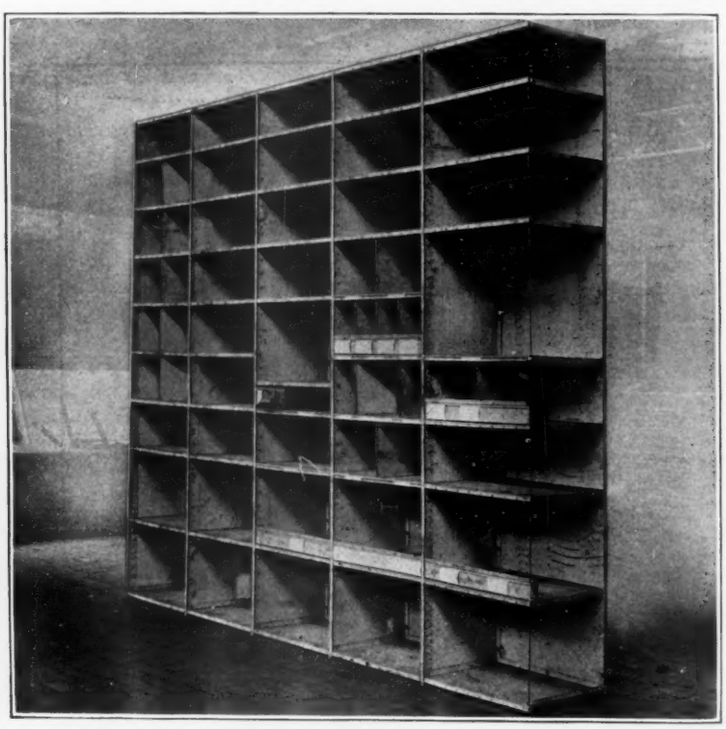


FIG. 6—STRIPPING PLATE MACHINE FOR CRANK CASE MOLD, WITH PATTERN LOWERED, SHOWING THE STOOLS

the foreground, and the casting is at the right. Fig. 6 is another view of this machine with the pattern lowered, showing the stools. In this illustration is also shown another view of the dummy for the drag, as well as the exterior of the crank case casting.

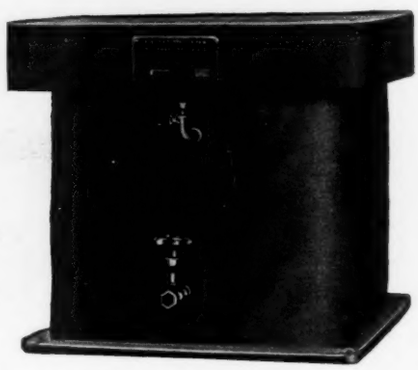
The arrangement of one of these machines for bench and gated work is shown in Fig. 5. Both cope and drag halves of the mold are made on one machine and the patterns for each are simultaneously lowered through the stripping plate. Four of the fan castings made in one mold are shown at the left of the base of the machine. Attached to the back of the machine and within easy reach of the molder, is a shelf, and another shelf, at the side, is provided for closing the molds. This machine is self-contained throughout and the conveniences provided for the operator greatly reduce the number of movements required in making a mold. The stripping plate and pattern on this type of machine can be readily removed and replaced with other patterns, which makes the machine interchangeable. Whenever possible, two irregular patterns of the same design are mounted on one machine on which both cope and drag are made. If only one pattern with an irregular parting were made in a mold, two machines would be required, and by arranging the patterns two in a mold, the output is doubled and the number of machines required is reduced one-half.



BERGER SECTIONAL STEEL BIN WITH END UPRIGHTS REMOVED

## Jar-ramming Core Machine

In the accompanying illustration is shown a jar-ramming core machine, 16 inches square by 14 inches high, built by the Herman Pneumatic Machine Co., Zelienople, Pa. It consists of a base, valve and combined table plate and plunger. The valve is located at the bottom of the machine and is arranged in such a manner that it will admit only a sufficient amount of air to lift the load. This arrangement materially reduces the air consumption. The table falls upon resilient surfaces, which is a feature of construction embodied in all of the jar-ramming molding machines built by this company. This machine is provided with side guides which relieve the wear and stresses that might otherwise be thrown upon the cylinder. The cylinder is lubricated by oil which



JAR-RAMMING CORE MACHINE

flows through a pipe projecting through the base of the machine and oil holes are provided in the table plate to lubricate the side guides. These machines are built in four sizes in capacities from 400 to 3,000 pounds.

## Sectional Steel Bin

For the storage of patterns, cores and small castings in foundries, as well as bolts, washers, screws, small machine parts, etc., in machine shops, sectional steel bins are now being widely used. In addition to being fireproof, the compartments of the bins can be increased or decreased in size and capacity to meet almost any requirements. The Berger Mfg. Co., Canton, O., manufactures a line of steel bins, as shown in the accompanying illustration. The backs for all compartments consist of continuous steel plates, which serve either as a back to a single-face bin or as the dividing wall between a double-face bin. Uprights are fastened at right angles to the back with stove bolts which pass through right-angle edges on uprights and holes in the continuous back. These

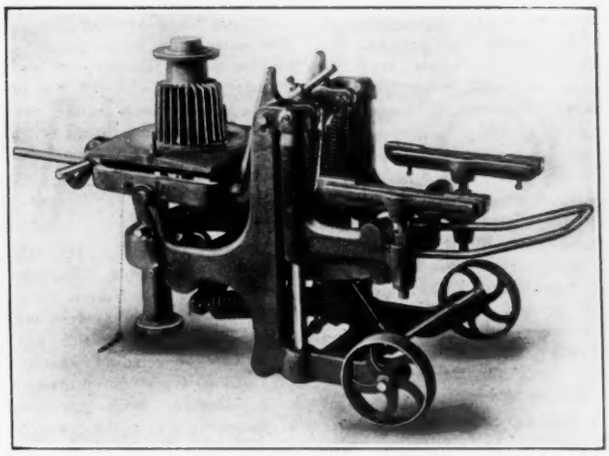


FIG. 1—ROCK-OVER MACHINE WITH LOOSE STRIPPING PLATE ATTACHMENT FOR MOLDING AIR-COOLED CYLINDERS

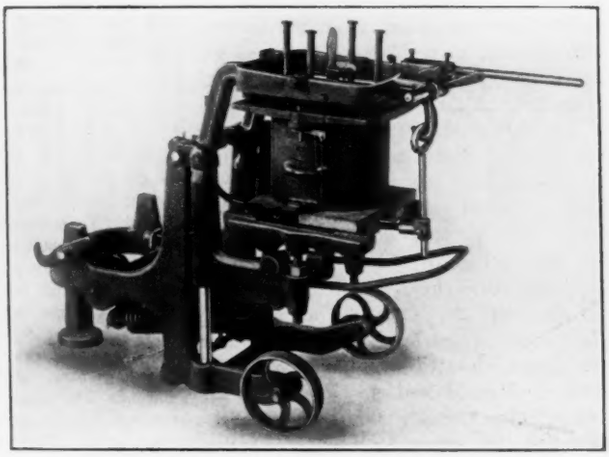


FIG. 2—THE CHEEK OF THE CYLINDER MOLD ROLLED OVER, BEFORE REMOVING THE CLAMP

uprights and the back each carry a portion of the shelf load, as the shelves are adjusted to uprights at the sides and to the continuous back in the rear of each compartment. The shelves are likewise fastened with stove bolts. The intermediate shelves are securely bolted to the uprights and to the continuous back, thereby securely holding the entire bin together.

This construction, however, while it insures rigidity, does not prevent the easy removal of the entire bin, nor the quick adjustment of its shelves. The bins are adjusted to 3-inch spaces which provide sufficient range for any storage space desired. Removal bin boards are furnished to facilitate the piling of small articles in any compartment. Vertical partitions, which can be easily placed in position, add to the utility of these bins. Label holders are also provided which extend the entire length of each shelf and permit of any number of sub-divisions. By the use of labels the contents of each division can be plainly marked. Extensions can also be added to the lower bins to make them deeper, thereby increasing their capacity. At the same time they form a convenient shelf, on which to rest boxes while the contents are being unloaded into the upper shelves. In these extensions the regular bin boards can be used. The space inside of the bins is free of braces and supports, thereby affording maximum storage space without sacrificing strength and stability. These bins are of steel plate construction and can be furnished in five different sizes, although special sizes will be built to meet any requirements.

## Molding Air-Cooled Cylinders

When molding air-cooled gas engine cylinders by hand, great difficulty is frequently experienced in drawing the pattern out of the sand without breaking parts of the mold forming the webs. When the webs extend horizontally around the cylinder, the molding difficulties are not as great as when the webs are vertical. In the accompanying illustrations is shown a rock-over drop molding machine, equipped with a loose stripping plate attachment, designed for molding gas engine cylinders with vertical webs. This machine was built and equipped with this special attachment by Henry E. Pridmore, Chicago, and will accommodate flasks, 16 by 14 inches, and has an 8-inch draw.

In Fig. 1, the pattern is shown in molding position. The mold is made in a three-part flask, drag and cheek being rammed on the rock-over machine, while the cope is molded on a stand. The cheek extends up to the flange and the drag contains the flange and the core print. When making the mold, the cheek is rammed first and this is followed by the making of the drag. The drag is lifted off and the bottom board is clamped onto the cheek part of the mold. The cheek rolled over, before removing the clamp, is illustrated in Fig. 2.

In Fig. 3, the loose stripping plate

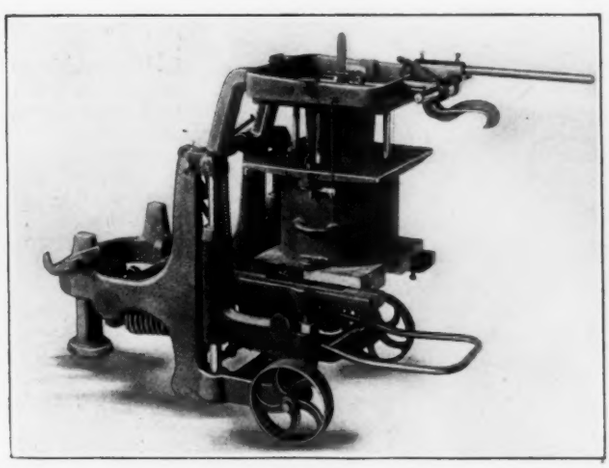


FIG. 3—LOWERING THE MOLD AWAY FROM THE PATTERN. THE STRIPPING PLATE IS IN CONTACT WITH THE TOP OF THE FLASK

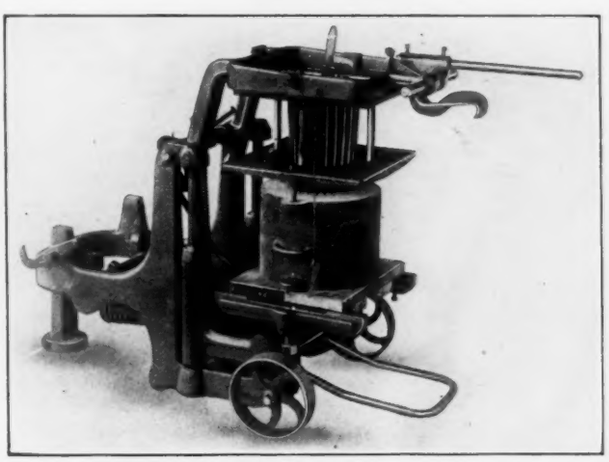


FIG. 4—THE MOLD LOWERED AWAY FROM THE PATTERN, SHOWING THE STRIPPING PLATE SUSPENDED

attachment is clearly illustrated. As the mold is lowered away from the pattern, the stripping plate likewise descends until it reaches its downward limit, which is below the air-cooling webs to insure a perfect mold. The continuation of the draw is illustrated in Fig. 4, which shows the mold lowered below the stripping plate and entirely clear of the pattern. The pattern and stripping plate are then rolled over into molding position and the cheek is lifted off and closed over the drag. The stripping plate is supported by four guides, which are shown elevated in Fig. 2, and lowered in Figs. 3 and 4. The webs of this cylinder are only 3/16 inch in thickness and the output by the use of this machine and stripping plate attachment has been increased to 85 molds per day.

## Trade Publications

HAMMER DRILLS. — The Sullivan Machinery Co., Chicago, in a bulletin recently issued, describes and illustrates its line of quarrying and stone dressing tools, comprising plug and foot hole drills, hand feed hammer drills for quarrying purposes, and hand surfacing and bushing tools for dressing stone.

FUEL OIL BURNERS.—In an eight-page pamphlet, issued by the Hauck Mfg. Co., 140 Cedar street, New York City, fuel oil burners for drying and baking molds and cores, and for general heating operations, are illustrated and described. Another pamphlet issued by this concern is devoted to portable crucible forges recently described in THE FOUNDRY.

DISC VENTILATING FANS.—The American Blower Co., Detroit, in a recently issued bulletin, illustrates and describes a disc ventilating fan. Efficiency charts and table of capacity are given and methods of installation are included. A number of unique folders and booklets are also being sent to the trade by the American Blower Co., which direct attention to its varied line of products including exhaust fans, forge blowers, pressure blowers and numerous types of ventilating fans.

TITANIUM.—Facts, figures and illustrations intended to prove that titanium has solved the steel rail problem, are contained in a 40-page catalog, issued by the Titanium Alloy Mfg. Co., Oliver building, Pittsburgh. At the present time more than 400,000 tons of titanium rails are in actual use and during 1910 statistics show that 195,940 tons of ferro-titanium rails were rolled. The extra cost of titanium treatment of rail steel is only about $2 per gross ton of finished rails. The illustrations included in the catalog show titanium rails in service on curves on numerous railroads.

GRINDING AND POLISHING MACHINERY.—In a 32-page catalog, the Webster & Perks Tool Co., Springfield, O., describes its extensive line of grinding and polishing machinery. This includes bench grinders, floor grinders, ring-wheel end grinders, special plate edge grinders, polishing and buffing lathes, overhanging head polishing and buffing lathe, and miscellaneous grinding attachments. This company also manufactures bevel safety flanges which are designed for use on the sides of bevel abrasive wheels between the regular flanges furnished with every grinding machine. Wheel guards or protection hoods are also manufactured for wheels from 14 to 30 inches in diameter and the hoods are interchangeable and may be used on either the right or left hand end of spindle.

LOCOMOTIVE CRANES.—The extensive applications of locomotive cranes are illustrated by numerous service views in a handsomely-illustrated catalog, issued by the Browning Engineering Co., Cleveland. The type of locomotive crane built by this concern can be equipped to handle a hook block, electric lifting magnet, automatic bucket of any type, drag scraper bucket, steam shovel dipper or pile driver hammer and leads. In general, the crane consists of a car body or traveling base, mounted on four or eight wheels. The gage is usually made standard, but can be arranged to suit any particular requirements. The construction of cranes of various types is described in detail. The illustrations show locomotive cranes in use in industrial plants of all kinds, including blast furnaces, steel works, foundries, etc.

AUTOMATIC STOP VALVE.—In a four-page bulletin, issued by the Rockwell Furnace Co., 26 Cortlandt street, New York City, the Lalor automatic stop valve, which is used for automatically stopping the supply of oil in case of breakage of the oil lines or abnormal flow to the burners, is illustrated and described. This valve completely eliminates any danger of fire or the loss of a large quantity of oil due to a breakage in the supply line. The valves can be so proportioned that they may be applied to any number of burners and automatically close if the passage of oil exceeds the maximum, acting not only as a preventive of an abnormal flow, but as a check on an excessive consumption of oil caused by carelessness on the part of the furnace operator. The valves are made in sizes from ½ to 4 inches.

SAFETY AS APPLIED TO GRINDING WHEELS.—An interesting, 26-page booklet has been issued by the Norton Co., Worcester, Mass., which contains descriptions and illustrations of safeguards which can be applied in the use of grinding wheels and machines. Various types of protection hoods are shown, together with instructions for properly mounting grinding wheels. The types of protection hoods include those constructed of steel bands that surround the periphery of the wheel, flexible adjustable link guards, riveted steel hoods, pressed steel hoods, etc. Dust systems for grinding and polishing rooms are also illustrated and described and numerous pertinent suggestions relative to speed changing, including a table of grinding wheel speeds are included. The booklet should prove of value wherever grinding wheels are used and if the suggestions contained therein are carefully followed, accidents will be either greatly minimized or entirely eliminated.

## General Industrial Notes

The United States Cast Iron Pipe & Foundry Co. will erect an addition to its foundry at Addyston, O.

The Union Foundry Co., Fitchburg, Mass., will shortly begin the erection of an extensive addition to its foundry.

The firm name of the Peck-Williamson Foundry Co., Oakley, Cincinnati, has been changed to the Williamson Foundry Co.

Frank C. Douds, New Castle, Pa., has purchased the foundry formerly owned by the Vulcan Foundry & Machine Co., at a cost of $45,500.

The American Radiator Co., Chicago, is erecting a foundry addition to its Pierce plant, located at Elmwood avenue and the N. Y. C. railroad belt line, Buffalo.

James & Guyman, Detroit, are erecting a foundry, 60 x 168 feet, for the manufacture of gray iron automobile cylinders. The melting equipment will consist of two cupolas.

The Vollrath Co., Sheboygan, Wis., will erect a three-story addition, 60 x 80 feet, to its present plant, which will consist of a machine shop, foundry and other buildings.

The North Manchester Foundry Co., North Manchester, Ind., has been incorporated with a capital of $10,000. The incorporators are J. C. F. Martin, John Stauffer and W. J. Ranger.

The Titan Steel Casting Co., Chapel street, Newark, N. J., will erect an addition to its main foundry, 150 x 200 feet and 42 feet high. The building will be of steel construction.

The J. J. Davitt Foundry Co., Springfield, Mass., has taken over the structural iron business of the R. F. Hawkins Iron Works. The capacity of both plants will shortly be greatly increased.

The Peerless Crucible Steel Castings Co., Detroit, has purchased five acres of land on the Detroit Terminal railroad and Oakman avenue, upon which it will erect a crucible steel foundry, 65 x 150 feet.

The G. E. Hoglund Foundry Co., Gardner, Mass., is erecting a new plant, 30 x 160 feet, which will be well-equipped throughout. A Whiting cupola will be installed. The plant will be placed in operation about Nov. 1.

The Gray Iron Foundry Co., Reading, Pa., has purchased the entire line of patterns from the National Brass & Iron Works of that city, consisting of mirror frames, tables, portables and other patterns for ornamental work.

The Rochester Steel Castings Co., Rochester, N. Y., has been incorporated with a capital of $50,000. The incorporators are Fred C. Kimmel, P. V. Crittenden, J. C. Emery, Henry C. Caldwell and William Deininger.

The Gardner General Foundry Co., Gardner, Mass., owing to the large number of orders on hand, will probably acquire the present foundry of the G. E. Hoglund Foundry Co., upon the completion of the new shop which is being built for the latter.

The Standard Machine Mfg. Co., Carthage, Mo., has taken over the Stout-Parke Foundry & Machine Co. of that city and will engage in the manufacture of deep well pumps, well drills and other drilling tools and supplies. W. H. Stout is superintendent of the foundry.

The plant of the Yeager-Hunter Stove Works, Spring City, Pa., was recently sold by the receivers, H. E. Campbell and E. Garber, to Allen W. Urner and Wm. P. Miles, at a price of $37,500. The sale carries with it the real estate and all of the property owned by the Yeager-Hunter Stove Works.

The Atlantic Foundry Co., Akron, O., manufacturer of gray iron castings, is erecting a new plant on Beaver street, 100 feet square, of brick and steel construction. The equipment was purchased from the Whiting Foundry & Equipment Co., Harvey, Ill., and consists of a 42-inch cupola, one 10-ton crane, two tumbling barrels, seven geared ladles, elevators, etc.